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Keywords Nordic region, Finland, Sweden, Norway, Denmark, information and communication technologies (ICT), foresight, scenario, roadmap, strategy

Abstract

The Nordic ICT Foresight project was launched in May 2005 with research partners VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. In the research process there were five research phases: 1) desktop survey, 2) SWOT analysis, 3) scenario and vision workshop, 4) roadmapping workshop and 5) action workshop. The research phases (3, 4 and 5) were carried out as focused workshops that applied different methods. Publication presents scenarios, roadmaps and action path analyses of the potential developments of ICTs on the Nordic level. Policy recommendations were formulated on the basis of the research process. Policy recommendations were divided into implementation strategies, i.e. actions that should be proactively pushed through on the Nordic level, and adaptive strategies, i.e. actions that are more reactive in the face of global developments.

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Tiivistelmä

Pohjoismainen projekti "Nordic ICT Foresight" käynnistettiin tutkimusorganisaatioiden VTT (Suomi), FOI (Ruotsi), SINTEF (Tanska) ja DTI (Norja) toimesta toukokuussa 2005. Projektin tavoitteena oli tarkastella informaatioteknologian tulevaisuuden potentiaaleja pohjoismaisista näkökulmista sekä luoda strategioita informaatioteknologian hyödyntämiselle pohjoismaisella tasolla. Tutkimuksen strategisia näkökulmia olivat etenkin IT:n kommunikaatio- ja vuorovaikutussovellukset, terveydenhuollon sovellukset, tuotantosovellukset sekä turvallisuussovellukset. Tutkimusprosessi suoritettiin viidessä vaiheessa: 1) taustaraporttien analyysi, 2) SWOT-analyysi, 3) skenaario- ja visiotyöpaja, 4) tiekarttatyöpaja ja 5) toimenpidetyöpaja. Projektin työpajat sovelsivat erilaisia ennakointi- ja työskentelymenetelmiä. Julkaisussa esitetään skenaarioita, tiekarttoja ja toimenpideanalyysejä informaatioteknologian potentiaalisista kehityskuluista pohjoismaisella tasolla. Tutkimustulosten perusteella muodostettiin politiikkasuosituksia. Politiikkasuositukset jaettiin ns. implementaatiostrategioihin eli toimenpiteisiin, joita tulisi edistää erityisesti pohjoismaisella tasolla, sekä adaptiivisiin strategioihin eli toimenpiteisiin, jotka pyrkivät enemmänkin reagoimaan globaaleihin kehityskulkuihin.

Preface

In May 2005, representatives of VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark) proposed a project on ICT applications in the Nordic context. In its generality, the topic was intriguing and yet it seemed crucial to generate some wide-ranging views on the field of economic activity that had created wealth through unique competencies in the Nordic area. The generality, however, posed the challenge of targets for the project: Where to aim in the vast field of ICTs? What are the key foci of this exercise?

The starting point was that the exercise should be future-oriented, scanning the horizons and probing the depths, but in a grounded fashion. This means that the limits of the exercise were defined from the Nordic perspectives – the search for future-oriented knowledge of ICT applications and infrastructures was primarily understood through a somewhat regional view by emphasising those branches of ICT that had some intrinsic value on the Nordic level. Of course, there was the advantage that the Nordic countries have such a rich dynamism in the field of ICTs – global players, dynamic SMEs, state-of-the-art research and development, advanced governmental cultures willing to adopt new ICT solutions and demanding customers – that the story to be told in this study was not to be just a regional one. It was, and undeniably is, a glocal story about the future of ICTs in one northern corner of the old continent that has, due to some unique societal features, technological developments, business innovations and historical-geographical paths, become an interesting territory on the map of ICT development.

After this kind of optimistic sketching of the Nordic regional dynamics, the unwritten law of literature on competitiveness and foresight states that one should also be reminded about the uncertainties looming on the horizon. The future is, of course, full of unstable factors, but one should also remember that in the horizon, amidst sinister signs, there are unseen possibilities and potential that are yet to emerge. And that is why the Nordic region is such an interesting field in which to study the futures of ICTs. The Nordic countries have tasted long-term success because of their unique branches of the welfare societies. Because of their R&D innovations and business dynamics, these countries have played a

key role in the development of the global information society. And because of their advanced education systems and SMEs, these countries still have potential to be at the cutting edge, despite the global challenges and changes in the balance of economic growth. The future is a landscape filled with peaks of possibilities for the one who understands the rifts and pitfalls.

In the springlike countryside between Salo and Karjaa, 29.5.2007

Toni Ahlqvist

Contents

1. Introduction

In May 2005, representatives of VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark) proposed a project on ICT applications in the Nordic context. The project was named "ICT Foresight and Roadmap towards Innovative Applications in the Nordic Countries", but it soon got the acronym "Nordic ICT Foresight". According to the original plan, the project aims were to identify, select and present scenarios illustrating the prospects for possible future applications for IC technologies with regard to technology, application and market issues. The specific aims of the project were to contribute to the strategic intelligence of the Nordic knowledge region. The main project core – a vision that has formed the bedrock of the workshop – was the general statement that the project should "increase the welfare in the Nordic countries and also in other parts of the world".

There were five research phases in the actual research process. In the first phase, the desktop survey, the boundaries of the technological field were defined. The second phase, the SWOT analysis, identified trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark. The third research phase, the scenario and vision workshop, had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of socio-technical ICT application visions. The fourth phase, the roadmapping workshop, created roadmaps on socio-technical visions on the levels of science and education, technologies, businesses and industries, markets and government. In the final research phase, the action workshop, a set of actions to be taken by the key players in the Nordic countries was depicted. In addition to these research-intensive phases, dissemination and evaluation activities were also included in the project.

There were four core partners in the project: DTI Danish Technological Institute, FOI Swedish Defence Research Agency, SINTEF Norwegian Institute of Technology and VTT Technical Research Centre of Finland (project coordinator). The core partners were responsible for project execution and the actual research process. In addition to the core partners there were some 15 cooperation partners that contributed to the Nordic ICT Foresight process by participating in the workshops and giving expert viewpoints in the different phases of the project.

As a systematic research report, this publication presents the actual working process of Nordic ICT Foresight in a rather transparent fashion. This publication has also a complementary summary report, which presents the results in a nutshell format. This systemic report is divided into nine chapters. Chapter 1 is the introductory chapter. Chapter 2 presents the Nordic ICT Foresight project structure and takes a quick glance at the most important theoretical frames of the project. Chapter 3 presents a summary of the desktop study and depicts the most important similarities and differences of the Nordic ICT trajectories. Chapter 4 reviews the SWOT analyses made by the four Nordic ICT Foresight countries and presents a Nordic level summary SWOT. The most important emerging ICT applications and generic technologies are analyzed in a future-oriented fashion in Chapter 5. Chapter 6 describes the scenario building process, which formed four external scenarios for the subsequent research phases. Chapter 7 depicts the process and results of the roadmapping workshop that created application and system-oriented roadmaps in the four Nordic ICT Foresight themes. Chapter 8 illustrates the action workshop that constructed the Nordic level action proposals for the creation of policy recommendations. Chapter 9 presents the policy recommendations formed after the research phases. The recommendations are divided into implementation strategies and adaptive strategies. Chapter 10 is a short summary of this massive publication. Chapter 11 presents the evaluation of the project.

2. Nordic ICT Foresight project structure and theoretical frameworks

2.1 Project partners and project structure

The Nordic ICT Foresight project (full name: ICT Foresight and Roadmap towards Innovative Applications in the Nordic Countries) was launched in May 2005 with the research partners VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. The more specific research and process aims were the following:

- to explore appropriate ways of implementing the innovative ICT applications and systems (prioritise research, development and commercialisation of ICT, consider the required infrastructure technologies)
- to estimate and compare the implications of the ICT applications in the Nordic countries (Denmark, Finland, Norway, Sweden)
- to create scenarios illustrating the prospects for possible future applications for IC technologies with regard to technology, application and market issues
- to build roadmaps of the developments in ICT applications in a ten-year timeframe
- to provide solutions whereby ICT can provide positive contributions to societal wellbeing
- to evaluate the Nordic opportunities in ICT with longer-term growth potential
- to assist in developing appropriate framework policies that facilitate the developments in the desired directions
- To evaluate and reflect on the elements that are unique in the Nordic culture in applying the ICTs. The special question is the following: What is the special value and meaning of the "Nordicness" in the context of ICT applications?

The Nordic ICT Foresight "project space" is depicted in Figure 1. There were four core partners in the project: DTI Danish Technological Institute, FOI Swedish Defence Research Agency, SINTEF Norwegian Institute of Technology and VTT Technical Research Centre of Finland (project coordinator). The core partners were responsible for project execution and the actual research process. In addition to the core partners there were some 15 cooperation partners that contributed to the Nordic ICT Foresight process by participating in the workshops and giving expert viewpoints in the different phases of the project.

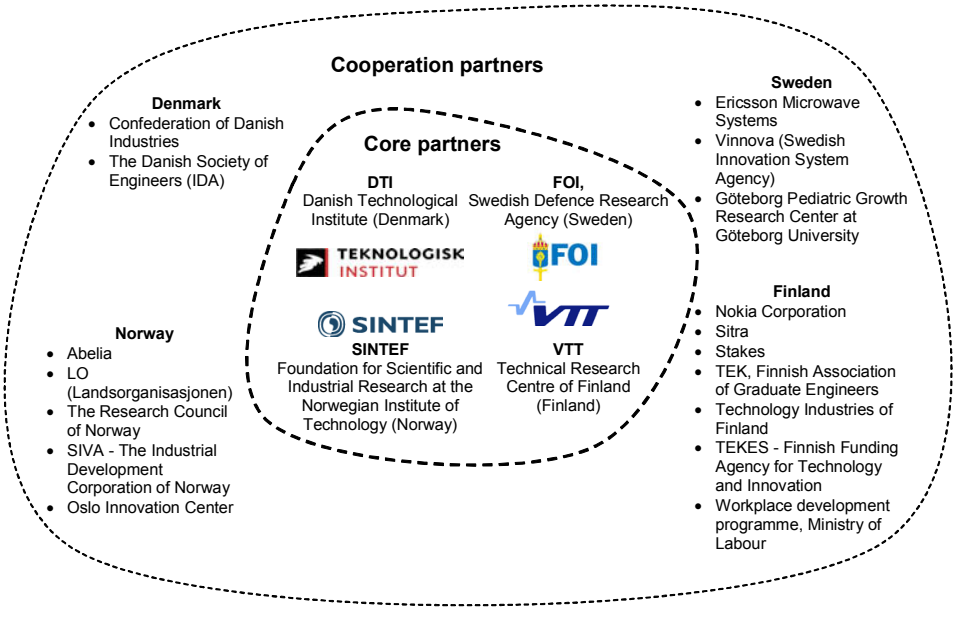


Figure 1. Nordic ICT Foresight partners and the project space.

The research process in Nordic ICT Foresight advanced through the following phases (see Figure 2):

Desktop study (leader: DTI). The first phase aimed at defining the boundaries of the technological field. It aimed at making the most of the existing knowledge and expectations in the ICT roadmaps in order to qualify the subsequent work packages. In this phase the major Nordic activities on ICT were mapped and related issues within research, industry, finance, and government policy in the Nordic countries.

SWOT workshops and questionnaires (DTI). The second phase aimed at depicting the trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark. The key ideas in this phase were to identify the strategies that these Nordic countries are currently following, to identify their key capabilities, strengths, key limitations and weaknesses in the future.

Scenario and vision workshop (FOI). The third phase had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of socio-technical ICT application visions. In the scenario building, the aim was to outline a set of external scenarios for the socio-technical environment around ICT in the Nordic countries from roughly 2007 to 2017. The focus was set on drivers for the future socio-technical environment that may act as substantial barriers or carriers for the adoption of selected ICT solutions. The aim of vision production was to brainstorm potential socio-technical visions for ICT applications in the Nordic countries and test them against the scenario set. The idea was to identify *robust implementation strategies*, strategies likely to help achieve ICT adoption under a wide range of external conditions. Where robust strategies are hard to find, *adaptive strategies* need to be defined. This means that alternative options are developed – subsequently to be exercised or otherwise based on external socio-technical developments. The two-day workshop was held in February 2006 in Bålsta, Sweden. There were 19 experts in the workshop.

Roadmapping workshop (VTT). The aim of the fourth phase was to create linkages between small and large socio-technical visions on the one hand and to characterise the required developments in science and education, technologies, businesses and industries, markets and government level on the other. An important element of the roadmaps was the identification of possible service and business opportunities and the most important technologies enabling these opportunities. The two-day workshop was held in May 2006 in Espoo, Finland, and attracted 24 experts.

Action workshop (SINTEF). The aim of the fifth and final research phase was to identify a set of actions to be taken by the key players in the Nordic countries in order to support the developments and successful implementation of the new innovative ICT solutions. After the workshop, the core team clustered and categorised the various actions into larger action fields, investigated how these

actions fields cope with existing policies, and identified key issues to take into consideration when realising actions. The one-day workshop was held in November 2006 in Oslo, Norway. 21 experts participated in the workshop.

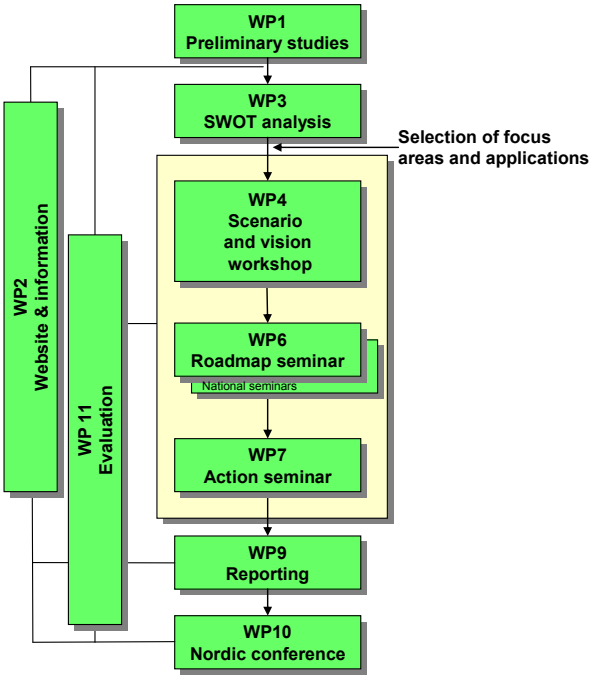


Figure 2. Nordic ICT Foresight project structure.

In order to facilitate the project management and circulation of information on the workshops, a project web-site was launched (http://nordic-ictfore.vtt.fi/). The final step in the Nordic ICT Foresight process is the project evaluation. In the evaluation phase, the knowledge obtained during the process will be analyzed from two perspectives: the perspective of technology foresight and the perspective of decision making. Special attention is to be paid to the lessons learned, i.e. positive and negative experiences concerning, facilitation of useful knowledge creation for decision support, Nordic TF co-operation, comparison of the outcomes and experiences with those of corresponding TF exercises (in other countries/regions, in other technological fields) and the contribution of the results and experiences to the scientific and professional knowledge base. By comparing the dynamics of shared knowledge creation in a number of foresight processes, valuable knowledge can be gained for the further development of Nordic foresight practices.

2.2 Theoretical frameworks

The general theoretical framework of the Nordic ICT Foresight is presented in Figure 3. The framework is divided into two general steps. The first step is the linking of the contemporary knowledge of IC technologies (*ICTs*) with the technological visions in the ten-year timespan. When these links have been characterized, a backcasting procedure is completed as the second step. This procedure is finalized through five societal levels that are defined as Nordic ICT Foresight project targets. These levels are: science and education, technology, business and industry, market and government. In the actual workshop process, the phases I and II (applications, generic technologies) clarify the levels of technology and, to some extent, the business and industry level. Other project target levels are analysed through the SWOT framework.

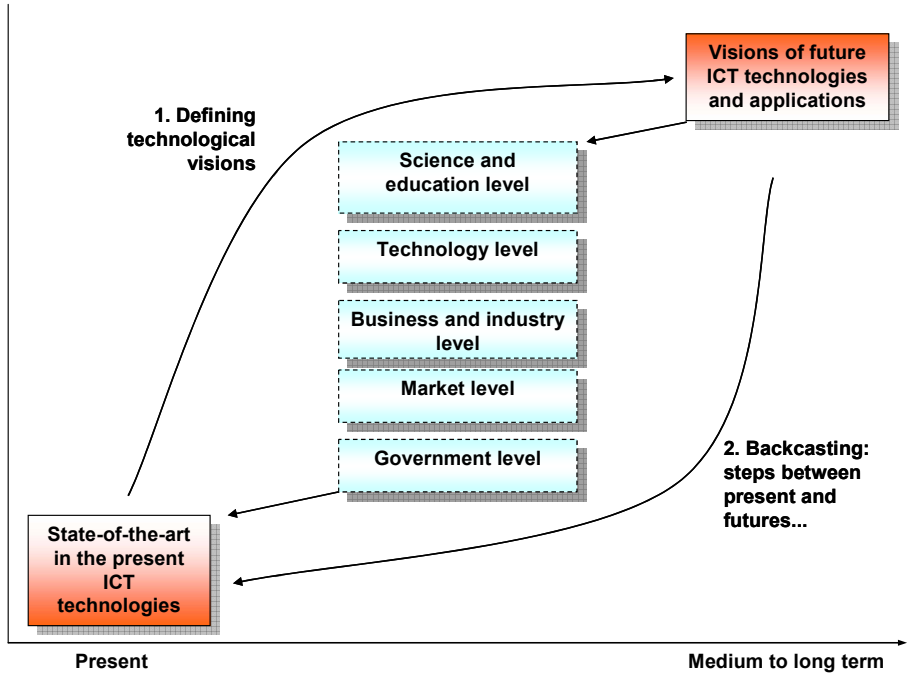


Figure 3. Technology foresight as applied in the Nordic ICT Foresight project.

The project's perspective on technologies is presented in Figure 4. IC technologies can be approached as a broad infrastructure of future society, but also as a potential spearhead permeating almost all societal sectors in the future

(Ahlqvist 2005). Therefore, ICTs can be seen both as evolutionary technologies and as weak technology signals. Evolutionary technologies refer to the crossbreeding and convergence of different technological trajectories as well as to the evolution in the separate technological field. In the evolution of IC technologies, many separate technological trajectories (e.g. network technologies, computer software, phone software, material packages) could be connected in new and innovative ways. For example, rapidly emerging Internet Protocol (IP) applications connect previously incompatible technologies through the common IP platform. Therefore, different technologies form a web of relationships that is constantly alternating and transforming. What is characteristic of this web is that its primary sources can be traced back in time. However, it is important to recognize that totally new technological possibilities and applications are emerging all the time. These new applications might be the economic spearheads of the future. New possibilities can be called weak technology signals. The monitoring of weak technology signals is a complicated task because it requires social probing outside the common frameworks and the ability to "taste" the emerging issues. It requires creativity and an ability to synthesize information, in the widest possible sense.

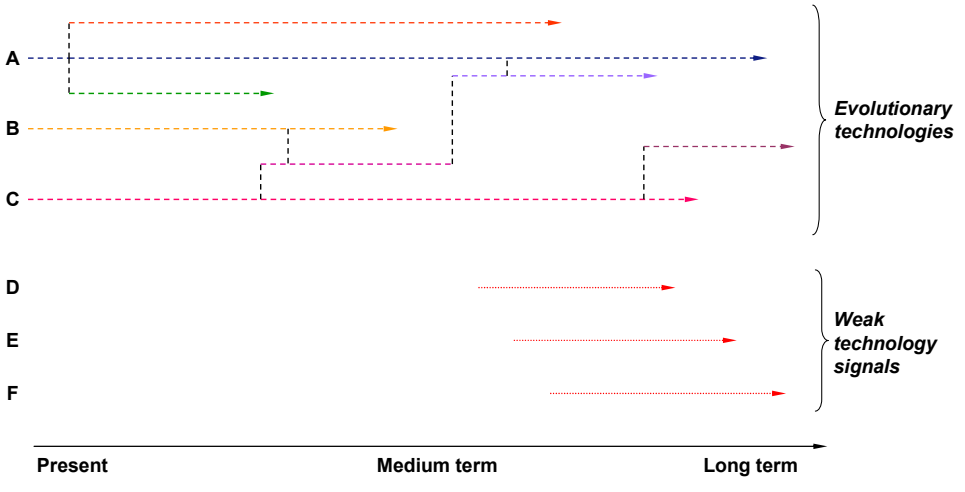


Figure 4. Evolutionary technologies and weak technology signals.

Considering ICTs, the perspective of the project emphasises the emergence of ad hoc heterogeneous networks. This development is endorsed by the different ubiquitous solutions. The general idea is presented in Figure 5. One may

consider ICTs at the start of the 21st century as a quite disparate group of technologies, where separate groups of products are quite easily identified. These separate product groups are then applied to different technological platforms (e.g. mobile, non-mobile, entertainment, work, production, and housing). Until this day, the logic of technological development has been quite fragmentary – the product groups are composed of solutions that might not have a strong common frame. However, in the future, and already looming on the horizon, ICTs are going through an intensification and increase in relationships. Now, new kinds of central platforms are being constructed. These central platforms, or central products, form the cores of converging modular technologies. For example, Internet Protocol can be one of the core technologies. Modular applications are beginning to form around these cores. The increase in the relationships and modularisation leads, in the third phase, to the convergence and compatibility of ICT product groups. The basis for the ad hoc heterogeneous networks is now constructed. Different platforms are combining and communicating with each other. Daily surroundings begin to be immersed in technologies that quite fluently enter into the everyday functioning of society.

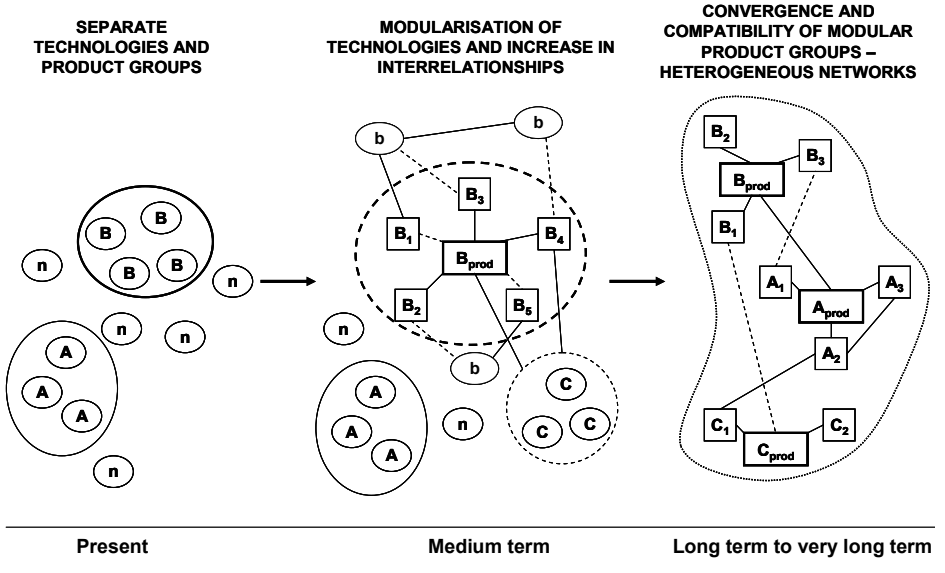


Figure 5. The evolution and convergence of ICTs.

3. Summary of the desktop study

3.1 Idea of the desktop study

This chapter presents a summary of the desktop study made by the Danish Technological Institute (Iversen et al. 2006). The aim of the desktop study was to give a comprehensive overview of the Nordic countries on the present and future opportunities related to the use of ICT within healthcare, security, the experience economy and traditional industry. More specifically the aim was to identify visions, strategic rationales and reflections on future challenges within the four Nordic ICT Foresight themes. The study utilised publicly available material on the four themes (see Appendix B). The material was mainly technological foresights, scenarios, and reports on visions and research for development strategies for the Nordic countries. This means that the material does not necessarily represent the actual policies or the political priorities of the four studied countries. Instead, the material gives some Nordic research perspectives on the policy issues and views on the challenges and opportunities in the four Nordic ICT Foresight themes. The reports in this desktop study summary are mostly made by researchers in governmental and non-governmental institutions.

It is important to reflect on this since it means that the content of this publication does not represent the political will and strategies of the governments of the Nordic countries but rather an overview of how the Nordic countries approach and analyse the four areas, and what opportunities for action national governments may have in relation to the four themes of Nordic ICT Foresight. The material available in the four countries differs a great deal in scope and scale. This is only natural since it reflects the difference in policy priorities as well as the difference in administrative structures and processes in the Nordic countries. But the difference in scope and scale means that the desktop study had the task to convey a more general description of how the Nordic countries define the four thematic areas.

3.2 Key results

The studied reports from the four Nordic ICT Foresight countries (Denmark, Finland, Norway, Sweden) quite clearly illustrate that there are significant differences in the scope, scale and goals of foresight activities in these countries. Since foresights are the primary source of information for descriptions of the Nordic countries' positions on ICT in the four themes, this means that clear comparisons between the different countries may be difficult. More specifically the differences in approach may be described using the following parameters; in Figure 6 these differences are characterised on the basis of four focal areas:

Society focus: A focus on the socio-economic drivers of changes and challenges that are directly or indirectly linked to the opportunities of new technology.

Technology focus: Descriptions of key technologies and how these may develop in the future.

Descriptive: A focus on well-defined descriptions of dilemmas and opportunities.

Ideas for initiatives: A report structure that leads to recommendations for political action in the innovation system.

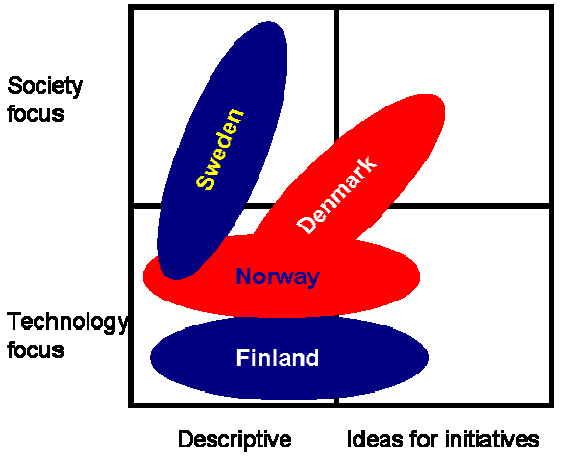


Figure 6. The basic emphases of the technology foresights in the Nordic ICT Foresight countries.

Naturally, these four focus areas are not mutually exclusive, and indeed many of the publications entail all four elements. But when the total amount of material available is analysed it is possible to identify the difference in approaches made by the Nordic countries and illustrate it as in Figure 6.

3.2.1 Experience economy

There is a common perception that the creative industries that belong to the experience economy are important. All Nordic countries identify strong positions in the experience economy and the underlying rationale is that these positions should be nourished since they deliver great value (economically and culturally) to society and are relatively hard to copy and/or off-shore. From a Nordic perspective then, the experience economy in itself is identified as a very important sector, but the role of ICT in relation to the sector is not analysed and discussed in the same thorough manner as the health care sector and traditional industry. One explanation for this could be due to the fact that the experience economy is not under the same kinds of pressure for change as healthcare and traditional industry. Another explanation may be that the potential benefits and new products form a lesser part of the total turnover and value in the experience economy as it does in traditional industry and the health care industry.

Much of Finland's focus on the experience economy is related to mobile technologies, where a range of new applications and location-based and context-aware services are expected to broaden the scope and scale for the use of mobile technologies. Marketing and entertainment are identified as the most important areas. In the Swedish and Danish material it is argued that the countries are strong in areas such as design, games and TV and film production, and that significant synergies with ICT should be expected and pursued in these areas. On the other hand, there is a fear that much of the future development of ICT and the experience economy may be located in the US, so initiatives should be cautious and well thought through from a long-term perspective. The reports from Norway also recognise the importance of the experience economy from a cultural and economic perspective and identify it as an important sector in Norway. But in the material available there are no links made between ICT and the experience economy, except for the possibilities to use ICT in relation to tourism.

3.2.2 Health

The reports from all four countries identify trends such as the aging society, individualisation and "user orientation" and the need to increase efficiency as important drivers for implementation of ICT in the healthcare sector. The use of ICT is, therefore, closely tied to a vision of a service-oriented cost-efficient healthcare system that is able to put the user in the centre. All countries rank high in one or more areas of e-health and, generally speaking, both healthcare systems and ICT infrastructure are described as well developed in all four countries. This means that the structural conditions for a strong development in e-health are in place. In Finland there was little documented information available in English, but the available material indicates that Finland has a very strong focus on ICT in healthcare and that the future development of bioinformatics is a focal niche for Finland. In Denmark, the available material conveys a strong belief that the Danish healthcare sector and ICT industry are strong in the areas of ICT in medical equipment, the development of sensor technologies, and electronic health records. In Norway and Sweden telemedicine and electronic health journals are identified as the major strengths and future focus areas. There are few concrete visions or suggestions for initiatives directly related to the suggested focus areas.

3.2.3 Production economy

All the studied countries share the same understanding of the pressure and opportunities that globalisation and developments in ICT create on the traditional production economy. All four countries lift ICTs as the centre of their strategies to keep traditional industries competitive. Historically, the Nordic countries are strong in different industrial areas and the industrial perspectives differ mildly in each country. But from an ICT and strategic perspective, many of the insights and visions for the future are basically the same. Basically, the ability to combine efficiency and flexibility for complex industrial products and production processes are at the heart of the visions for the use of ICT in traditional industry. In relation to this vision, Denmark identifies its most promising areas of ICT strengths as software for production planning and control, sensor technologies and wireless technologies. Finland's focus is on mobile and wireless infra structure and set-up in geographically disperse

production units. Sweden has a strong focus on complex production systems while Norway has a strong focus on the special challenges related to SMEs.

3.2.4 Security

ICT and security may be defined and discussed in many ways. Based on the studied material, two definitions are ICT security predominant. The first definition, here named system security, understands it as a practice that thrives to prevent the misuse of ICTs, dealing with such issues as viruses, spam and phishing. The second definition, here named network security, sees ICT security as the secure use of ICT in security applications and systems ranging from home security and alarm systems to modern weapons and defence systems. These two definitions are different, and this is also reflected in the studied material.

Material from all four countries put the system security perspective high on their ICT agendas since the lack of security may become a severe barrier for development of new ICT applications and markets within consumer and business segments. System security is not viewed as a strategic area for business development as such, but rather as a prerequisite for the future development of the information society. Consequently, few ICT-related strengths are identified in system security. Instead, a range of socio-cultural factors are identified as a means to strengthen citizens' and business focus and understanding of the importance of ICT security.

Network security is only explicitly addressed in the material from Sweden, where it is highlighted as a very important area in which Sweden has significant strengths and opportunities due to its strong tele-industry and security and defence industry. Given the nature of the subject, the fact that no material is available publicly does not necessarily mean that none of the other three Nordic countries are interested in the subject and/or has companies and research communities focusing on the area.

3.2.5 Synergies and complementary areas

Seen from an ICT perspective, mobile/wireless technologies are central in all four countries when strengths and opportunities are identified. Furthermore, the wireless technologies (and sensor technologies) are deemed important in relation to the four Nordic ICT Foresight themes. The mobile/wireless technology would therefore seem an obvious choice for enhanced focus and strengthening of Nordic ambitions for development. Of the four themes, it seems as if there are significant synergies between the four countries' initiatives within e-health and production systems. In relation to the experience economy, the area as such is identified as important in all four countries but the role of ICT and opportunities related to ICT is predominantly positively reviewed in the material from Denmark and Finland. ICT system security is identified as important in all four countries but not described as an area of strength or opportunity from an R&D or business perspective. Networked defence is only described in the Swedish material. Wireless/mobile and sensor technologies are central in this application area. It would seem advisable to further investigate the opportunities for the creation of Nordic focus in this application area.

3.3 Conclusions: prioritisation of the focus areas

In the latest round of the Swedish foresight (2006) there is a focus on the theme of holistic strategic choices rather than a focused or "restricted" technological and/or economical basis. The underlying line of thought is that the increasing global competition in the knowledge-intensive sectors means that the Nordic countries cannot allow themselves to compete in too many areas due to a lack of human and economic resources. On the other hand, the development of knowledge and technology becomes increasingly important as low-skilled labour is being off-shored or near-shored to low-cost regions. Indeed, the strategic choices are not just questions of more or less technology and research. Since it is the general model of society that is brought under pressure by globalisation and cultural and demographic trends, it is in this light that the opportunities and threats must be analysed and choices made.

In this sense, choices related to national R&D strategies and use of technology are moving from a strictly technological realm towards societal and cultural

realms. This makes the choices more politicised since the choices are directly linked to the visions of the future societal models. To sum up: although there may be several interesting areas identified in the different Nordic foresights, selecting narrow and dedicated foci would seem to be a more prosperous strategy than a broad and general perspective. Of course, the actual choice of foci must be made with an understanding of their more general implications for society as such.

This line of thought is not something that is reflected in the studied material, but current work and political processes indicate that the same reflections are being made in all Nordic countries (e.g. the work of "Globalisaeringsrådet" in Denmark and the work of "VEIVALG" in Norway). While the Swedish round of foresight has highlighted the holistic approach to foresights, one should also recognise the pitfalls of this approach, namely that the amount of information may significantly slow down the processes and implementation.

4. National SWOT analyses

4.1 Background to the SWOTs

The national SWOT analyses aimed to depict the national characteristics of the four project countries within the context of the international business and research environment in ICT. A strength in this context refers to a resource or capacity the unit of analysis, i.e. the nation, can effectively utilise to achieve specific objectives. A weakness is a limitation, fault or defect that will keep it from achieving its objectives. An opportunity is any favourable situation in the nation's environment. It is usually a trend or change of some kind or an overlooked need that increases demand for a product or service and permits a firm to enhance its position by supplying it. A threat is any unfavourable situation in the national environment that is potentially damaging to its strategy. The threat may be a barrier, a constraint or anything external that might cause problems, damage or injury.

In Nordic ICT Foresight, SWOT analyses were carried out in a slightly differing fashion in different countries, e.g. in Finland it was kept as a single workshop, in Denmark a series of four thematic workshops and in Sweden as a combination of small-scale questionnaires and interviews. Indeed, there was some latitude in the execution of the analyses as long as five certain criteria were matched. These five criteria were 1) to identify the current or prevailing strategy or strategies the Nordic country is following, 2) to identify the key changes in the international business and research environment in ICT based on the desktop survey (phase I), 3) to identify the key capabilities, strengths, limitations and weaknesses of the country in question, 4) to list key environmental issues against the relevance of the current strategy and the strengths and weaknesses of the Nordic countries, and 5) to examine the formed SWOT statements against each other. The key cross-cutting idea of the SWOT was that it was supposed to be future-oriented and focused on the environment of the ICT development.

4.2 National SWOTs

4.2.1 Finnish variation

The Finnish SWOT workshop was organised in December of 2005 in Espoo (see Ahlqvist 2006a). The key question was: What challenges will the defined applications and generic technologies pose for the Finnish economic environment in 2015? The SWOT analyses were realized slightly differently in groups 1 and 2. In group 1 the SWOT was conducted by collecting a long list of variables, which were then condensed and categorized by the group facilitator. In group 2 the SWOT analysis was based on the consensus method, where the facilitators discussed with the group and tried to reach a consensus on every statement.

Group 1. Table 1 presents the result of the Finnish SWOT analysis group 1. The results of the analyses are interpreted through four categories: State functions, corporations and market functions, universities, competencies and research functions, and cultural and regional functions. The *strengths* of the State functions in the Finnish system are State subsidies, the role of the State as an advanced regulator and the ICT infrastructure. The situation reflects one crucial element in Nordic innovation style: it is not based on lean and mean market capitalism but on the combination of State capitalism and competition-based capitalism. The State acts as an advanced regulator that provides legislative frames for the utilisation of ICTs in society. The State also acts as a financier and a demanding customer of ICTs. In the case of Finland, the success of the combination of welfare state and competition, as Castells and Himanen (2001) and Häikiö (2001) described it, was also partly based on good timing and pure coincidence: the telecommunication regulations were opened for free competition in the late 1980s, when the telecommunications cluster was beginning activate and form its bases. It should, of course, be emphasised that the Finnish variation of the Nordic system could not form without advanced markets and corporations. One of the strengths in the Finnish system is that people and firms are not prejudiced towards technologies and new products are quite easy to pilot. The role of universities and education systems has a lot to do with these attitudes. The Finnish education system gives a high level of basic education, which can then be directed towards different competencies and business and technology fields. Universities have traditions in applied research and, basic

education can also be quite easily linked with branches of information technologies, especially in navigation and health sector. Cultural and regional issues play an important function in the Finnish case. Finnish municipalities adopt new technologies quite efficiently. This has to do with the standard level of education – especially language skills – and positive attitudes towards technologies.

Table 1. Results of the Finnish SWOT – group 1.

Strengths	**W**eaknesses
• State subsidies: economic and political • State is advanced regulator • ICT infrastructure • Advanced markets: new products are easy to pilot in the consumer markets • Advanced corporations in many sectors • IPR/patent base • Cooperation between corporations and universities • Competencies in mobile technologies and industries • Competencies in RF and communication technologies • High standards of applied research • Strong R&D system • Education system can be integrated with the competencies needed in information technologies > navigation competencies, control of health information • Municipal communes are advanced and ready to reform • People are willing to try new things • People are educated and all-around education is high • Positive attitudes towards technologies	• Orientation towards regional development: one should not endorse national solutions • Lack of capital and finances • Tax incentives • The chain between ideas and commercial solutions is leaking **(2)** • Small country, small resources, small markets: should one have pilot customers abroad? • Too little venture capital funding to improve new businesses, lack of risk funding • One should master the ways to standardise things • Abilities to utilise new technologies • The level of basic research in technical universities • Convergence of the information systems is slow • Technological orientation > the social dimension is often forgotten
Opportunities	**T**hreats
• Attractiveness: the marketing of Finland as an internationally interesting research and development field • Developing new ways of acting: from the regional development orientation towards "open innovation processes" • Strong investments in certain competence areas • Proliferation of business orientation in ICTs • New products and new markets • New mobile services as support system for healthcare • Direct orientation towards international markets • Combinations of sciences • Coming revolutions in industrial automation	• Weakening of the sovereignty • Lessening of the resources and finances • International competition is tightening: Finland moves slowly, language differences, remote location, image • Rigidities in the cooperation among different sectors and branches • Multinational sectors dictate the directions • Not just production but also research and development moves to Asia • Difficulties in giving up the old • Distribution of competencies to regions • Diminishing of the autonomous thinking • Parochialism: things should be seen from a global perspective

The *weaknesses* of the Finnish system can also be categorised in the State functions, corporations and market functions, universities, competencies and research functions, and cultural and regional functions. The key weakness that

was discussed has to do with high State taxes and lack of finances. It was discussed that the State, although an advanced regulator and customer, is also quite rigid when it comes to finances and taxes. Rigidities inhibit the dynamics of SMEs because hiring people is becomes too risky. The Finnish system has strong emphasis towards regionally equalizing policies. This emphasis is two-sided. On the one hand the competencies diffusing across the State territory ensure more egalitarian development, but, on the other hand, the dispersing of the finances and competencies do not form the best possible dynamics between universities and firms. The weaknesses in the corporations and market functions are linked to this dispersal of competencies. In the Finnish system the links between ideas and commercial products do not work in the most efficient way. This is a dilemma that has gathered quite a lot of government attention. The problem is partly based on the small population and too small home markets. In addition, learning to commercialise and even taking a few steps forward and standardising the innovations would be an important development goal for the future. At the university and research level the most important problems are abilities to utilise new technologies. The level of basic research was criticised in the discussions. More funding should be risk funding and funding after the research, and an emphasis should be on the creation of businesses on the gained research results. It was also seen that part of the Finnish problem is the primary drive of technology: social level and social applicability is often forgotten.

The future *opportunities* for the Finnish system according to the workshop discussions are also classified into four categories: State functions, corporations and market functions, universities, competencies and research functions, and cultural and regional functions (Table 1). In State functions the central emphasis should be on marketing Finland as an investment possibility. The State should also loosen up its regional policy stresses and promote new links between actors in the innovation system. The innovation ecology should be allowed to form more “openly”, despite its centralising tendencies. In corporations and market functions the discussants saw many opportunities. There are strong investments in certain branches (e.g. mobile technologies) and the business and customer orientation is proliferating. New products are being developed in the new potential branches, e.g. healthcare. One of the key opportunities in the Finnish system is the ability to connect different sciences and sectors. The products are more oriented towards international markets. The anticipated revolution in industrial automation (convergence of information systems, IP based platforms,

mobility, RFID) was seen as a huge possibility for the Finnish system. It was also emphasised that internationalisation (e.g. the China phenomenon) is not merely a negative thing downsizing Finnish production. It is also a quest for new markets and new niches for applicable Finnish innovations. One interesting thought was to apply the idea that Japan followed in the 1980s: to adapt basic research and development made elsewhere and direct the Finnish innovations to the production phase. Creation of advanced products does not always mean that all the basic research should be done in the country where the potential production sites lie. Sometimes the value and advantages of some research results are linear and obvious, sometimes more non-linear.

Threats can also be packed in the four categories: State functions, corporations and market functions, universities, competencies and research functions, and cultural and regional functions. In the State functions the most focal threats were the weakening of sovereignty and further decrease in finances. The State has a central role in balancing the innovation systems so that basic research, applied research, product development and production are not totally driven by the fluctuations in the global markets. In a small country like Finland it is crucial that some national continuities – possibilities for open basic research, experimental research, applied research – are preserved, even when the short-term global trends might point otherwise. In the corporations and market functions the most important threats were connected to the slow movements in the face of international competition. Rigidities in the cross-sectoral cooperation were also seen as a problem. In research the basic threat is that not only production but also research and development functions are transferred to countries with cheaper labour and potential markets. Some cultural and regional points were also seen as threats. Although advanced in applying ICTs, the discussants still demanded more agile proactivity in the adoption of new applications. The discussants accentuated that resources and competencies should not be diffused around the country just for the sake of egalitarian regional policies. And in the face of standards and global trends, one should promote autonomous thinking that could find new solutions to issues. However, the emphasis on autonomous thinking should not lead to parochialism. Quite the contrary, even unique thoughts and moves should always be considered in a more global context.

Group 2. Table 2 presents the result of the SWOT analysis of group 2. The most important *strengths* were competencies in the mobile sector. It was discussed that Finland has quite clear spearhead sectors, where more inputs and finances should be directed. In addition, it was discussed that a Finnish strength is the political commitment to the development of the ICT applications in the wellbeing and health sectors. This point was, however, debated and criticised quite heavily. It was described that this policy is based on a more general feeling that "one must do something" than on the true recognition and analysis of the possibilities in this field. The key strength of the Finnish system is an application-oriented research and development culture, which is why technical solutions are quite easily developed in Finland. Commercialisation is the phase where the more serious trouble starts.

The Finnish *weaknesses* lie in certain competence areas, size, business and financing. It was estimated that there are gaps in certain technical areas, although the Finnish system is generally strong in explicitly technical sectors. One discussed example was new screen technologies. This point delivers one crucial thought: the Finnish system is strong on current information technologies, but is it developing potentially successful applications in the future as well? Another weakness is the small population and small resources, and the constant need to focus because of these. In addition, the issue of commercialisation was raised as a central weakness, as well as an undeveloped risk financing system that would back the commercialisation of innovations.

Table 2. Results of the Finnish SWOT – group 2.

Strengths	**W**eaknesses
• Strong competencies in the mobile sector > strong spearhead sectors • Commitment to the development of the ICT applications in the wellbeing sector ("one must do something") > the point was criticised in the discussion • Application-oriented culture (R&D)	• Gaps in the competencies > technical competencies, for example new screen technologies • Small population > the need to focus research and education, the need to select the aims • Finns can handle technology and design, but others take the business • Undeveloped risk financing
Opportunities	**T**hreats
• Potential new export products and services > e.g. applications of the wellbeing sector • Cost-effective data transmission solutions in the sparsely populated areas • Mobile application markets in the Third World > e.g. connected to energy systems	• China & India • "New illiteracy" • One cannot find risk financing for the development of added value applications • Consumers do not feel that the value of applications are worth paying for • ICT applications demand stable development, the benefits of the ICT applications fade in global risk situations

Opportunities were seen in potential new export products, new data transmission solutions and new markets. ICT applications in the wellbeing sector were seen as a potential source of new exports. Cost-effective data transmission solutions could also bring forth new kinds of possibilities for living in more peripheral regions. New markets in the Third World could bring "spaces" for solutions. For example, ICTs connected to energy systems could be a possibility. Nonetheless, the search for new markets in Third World countries needs input in the development of interfaces and very cost-effective ways of production. The products should be tailored to local needs and competencies, and the exports should be primarily focused on quite low-cost products.

The focal *threats* to the Finnish system can be summarized in five points. Developing markets, epitomized in the cases of China and India, were seen as huge risks. ICT applications may suffer from "new illiteracy", the gaps in the digital competencies. It is, therefore, crucial to analyse the social and cultural potential of the probable innovations. It is also pivotal to make ICT applications as "unproblematic" as possible. This issue is emphasised in the development of interfaces. The lack of risk financing was also seen as a serious threat. In addition, the development of applications that consumers are willing to pay for is becoming more and more challenging. It was interesting to note the link between ICTs and stable development; cutting-edge ICTs can only be developed and applied in a stable environment – in the more unbalanced situations, ICTs become totally useless quite quickly.

4.2.2 Swedish variation

The Swedish SWOT analysis was carried out as a combination of small-scale questionnaires (5 respondents from FOI, 5 respondents from the industry and health sectors) and interviews. The focus of the analysis was on the Swedish innovation system in the adoption of ICT in the general sense and more particularly on the health, production economy and security sectors. The Swedish SWOT was made on health, production economy and security. In addition, a summary of the general findings was also done.

In the general SWOT (Table 3) the key strengths of the Swedish system emphasised such general factors as the informal system of the Swedish

governance without too rigid hierarchies and also the nation's tradition in applying ICTs in many societal and industrial sectors. The highlighted weaknesses were a decreasing interest in science and technology education among the Swedish youth, low salary rates in R&D, lack of financing for the early phases of SMEs and an unclear division of labour among governmental agencies. The most important opportunities were pragmatism in the adoption of ICTs and a user culture emphasising early adoption of advanced ICT applications. The identified threats were related to the size of the home markets and, hence, lack of funding for the developments.

Table 3. General findings of the Swedish SWOT.

Strengths	**W**eaknesses
• Informal system; no hierarchies • Wide spread of ICT use • Long tradition of use of ICT in many sectors of society • Knowledge of high-level system development • Infrastructure	• Decreasing interest in science and technology education • Low salaries in R&D • Lack of financing of the early phases of firms • Unclear division of responsibility among agencies
Opportunities	**T**hreats
• User infrastructure • Pragmatic R&D climate • Early adopters	• Small home market • Financing

The Swedish SWOT on health is presented in Table 4. The most important strengths in health are strong niches in selected tech areas, like sensors, biotechnology and ICT security. A crucial factor in the development of eHealth solutions is that elderly people can also be somewhat early adopters – there are elderly people with quite high ICT literacy. Public interest in ICT healthcare is an important factor in developing the applications. The most important weaknesses of the Swedish health sector lie in the old-fashioned education system. The health system could also be more integrated and compatible with ICT solutions. An interesting issue is that although a portion of the aging population can act as early adopters there is still too little general demand, and the local health institutions are not early enough "buyers" to create a demand to pull the R&D. Opportunities can be found in the end-user emphasis and in the creation of common Nordic markets and testbeds for the health applications. The key threats are unclear division of responsibilities between the actors, a cultural division between IC technology development and the health sector, lack of business models in the health sector and lack of sufficient directing of legislation to back up ICT adoption in the health sector.

Table 4. Swedish SWOT on health.

Strengths	**W**eaknesses
• Niches in selected tech areas (sensors, bio-tech, IT security…) • Some excellent research environments • Even elderly are early adopters • Climate of innovation • Huge interest in ICT healthcare	• Stovepipe-like education • Conservatism; proof of concept • Weak demand; "no early buyers" • Weak integration with today's IT systems • "Pedagogical skills"; need to describe the utility
Opportunities	**T**hreats
• Everybody agrees resources are limited -> ICT could be part of solution • Put the end user in focus • Create a single Nordic market • Nordic demonstrators • "Nordic view" of healthcare • Strong confederation in the area	• No solution to the "division of responsibility" problem • "Cultural divide" tech-health • Standardization, others run faster • "We are the best" thinking • Security and integrity; must be solved • Need to find good business models • Development of legal system

In the Swedish SWOT on production economy (Table 5) the key strengths are good and working cooperation between industries and universities, good R&D activities in production simulation and strong ICT knowledge in telecom and automobile industries. The weaknesses in the Swedish production economy are in the ICT capabilities of some producing industries. Also, the ICT is not applied in the first parts of the production chain, such as ideation and concept formation. A key opportunity lies in the increased interest of financial institutions towards the research in production. The most crucial threats could be the deterioration and diffusion of the R&D competencies in the face of globalisation and too weak concepts for the commercialisation.

Table 5. Swedish SWOT on production economy.

Strengths	**W**eaknesses
• Cooperation between industries and universities • Strong R&D base in production simulation • Strong ICT knowledge, particularly in telecom and automobile industries	• Difficulties in attracting students in relevant areas • Parts of producing industry weak ICT knowledge • Use of ICT in late production phases; not in early conceptual phases • Weak support for SMEs' adoption of ICT
Opportunities	**T**hreats
• Some increased interest in production research from financing institutions can be observed • Smart ICT application gives possibility to still have production in Sweden	• Risk that SMEs are forced to close down; can't keep up with the R&D cycle • The weaknesses in the commercialisation phase can have bad influences on the research area

The Swedish SWOT on security is presented in Table 6. In this theme the central strengths are large established companies like Ericsson, Securitas and the Defence Industry that can act as demanding customers and drive the field as a

whole. Furthermore, the small population in a large territory creates the need for the development of all kinds of semi-autonomous security solutions. There are also many players in the field and cooperation has found its channels already. The pivotal weakness in the Swedish system is that there is no experienced "primal threat" that could foster the developments in the theme of security. The small size of the players might also be a disadvantage in the development. The opportunities are to be found in the emerging 24/7 service sector, development of networked-based defence concepts and in niches. The essential threats are too low government investments, small home markets and the tendency to see security as a need rather than a business opportunity.

Table 6. Swedish SWOT on security.

Strengths	**W**eaknesses
• Large established companies (Ericsson, Securitas, Defence Industry,…) • Small population, large geographical area -> surveillance solutions • Many players; cooperation natural	• No experienced real threat • Sweden is under-represented in EU financed R&D • Small players
Opportunities	**T**hreats
• EU financing • "24h service sector" • Networked-based defence • Niche as tech lead for SMC, for which "big solutions" are not suitable	• Other countries invest in security, Sweden less interested • Security as a need rather than a business opportunity • International competition • Small home markets • US dictates conditions

4.2.3 Norwegian variation

The Norwegian SWOT analysis was carried out as a workshop that followed the process presented in Figure 7. The SWOT workshop focused on the themes of experience economy, health, ICT production and security.

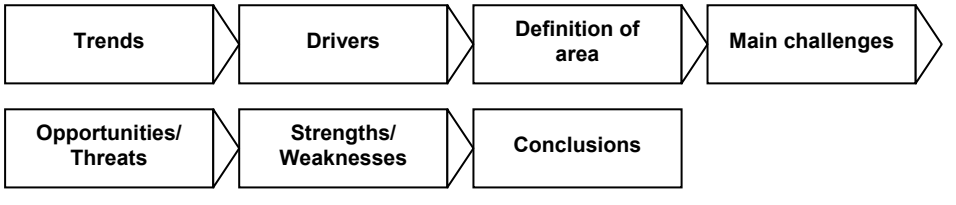


Figure 7. The Norwegian SWOT process.

The Norwegian SWOT on the experience economy is presented in Table 7. According to the results, the strengths in the theme were advanced users/customers, high coverage of ICTs among the people, and some successful readjustments of national institutions working in the theme. The key weaknesses can be labelled under the innovation systems, which include difficulties in the development of a niche in small markets, fragmented clusters and small firms. Another issue raised in the workshop was the question of Norway's international emphases – Norway was seen as somewhat nationally bent. Opportunities in the theme circled around the development of new user-driven applications and services as well as the development of an infrastructure, such as new terminals. The crucial threats were IPR, DRM (digital rights management), the effects of global actors, lack of interoperating systems and formation of monopoly structures in the industries.

Table 7. Norwegian SWOT on the experience economy.

Strengths	**W**eaknesses
• Advanced users/customers • International testbed • People like to have advanced technology • Wealth, purchase new devices • Early adaptation of new services • High coverage • Successful readjustment of national institutions	• Difficult to develop niche products in a small country • Are Norwegians internationally oriented after all • Innovation system • Culture for developing technology, not business • Not utilising possibilities for patenting • Less competence • Small enterprises, fragmented clusters
Opportunities	**T**hreats
• IPR • User-driven development • Framework condition acceptable • New standards, both de facto and official • Globalisation • Application-driven services • New terminals • Growth in consumption	• IPR, DRM • Lack of consumer understanding • "Bad" regulations • Global actors • Lack of interoperability • Creation of monopolies that slow down development • DAB discussions

The Norwegian SWOT on health (Table 8) labelled the issue that public administration controls the general development a strength. Also, the existing quite close markets between the Nordic countries with some early adoption capacity were seen as a pivotal strength. This idea of a Nordic test market was thus highlighted in the Norwegian SWOT too. The substantial weaknesses in health were the too few number of firms in the area, resistance in adopting new systems and the public agencies' focus on cost optimisation instead of business development potential. In the Norwegian context, the public agencies can also act as an opportunity in the creation of advanced demand. In addition, actors on

a general level are quite willing to adopt new technologies if the funding structure gives some latitude to move. There some crucial "early adopters" in certain market segments. Besides, the global actors in the country can play an important part in the formation of advanced demand. Focal threats were limitations to combining knowledge. The public sector can make the market situation quite unstable by buying and selling at the same time. Govermental funding, in addition, does not easily take the risks that are needed in the creation of successful health applications.

Table 8. Norwegian SWOT on health.

Strengths	**W**eaknesses
• Public administration covers overall systems • Short communication lines between the different markets within the Nordic countries • Early adopters • Scandinavia as a market open for development of advanced medical equipment • No separate medical ICT business sector • Individual freedom to act and willingness/ability to act on their own	• To few health-related ICT enterprises • Limited flexibility/ ability for thinking new • Health authorities only focusing on cost, not on possibilities for new business/products • Unstable external conditions and public position • Too small home market/resources to develop advanced medical equipment
Opportunities	**T**hreats
• Possible deliveries due to public systems with an overall view • Societies with a homogeneous attitude towards taking new services/products into use. Possibilities for establishing new business • Dependent on the public authorities' ability to focus on both low price and new products • Norway and the Nordic countries have a good reputation – products from these countries are often preferred. Danger of getting sued is lower in the Nordic countries • "Early adopters" within several technology/market segments. Global actors put effort in development in the Nordic area	• Limited flexibility/willingness to think in new ways. i.e. struggles between professionals • Society as a customer will not take the risk related to new technology • The public sector is selling and buying at the same time, unstable position • Rate of development may be slowed down due to liability for damages • Expensive to develop medical equipment for small nations • Governmental regulations (security) • Nordic countries are very interesting for the global actors

The Norwegian SWOT on ICT production is shown in Table 9. The major strengths in this field were competitive costs and stable manpower, high degree of automation, the industry's willingness to adapt new ICT-based production methods. There are also some well-developed clusters in ICT production and important niche applications based on Norwegian specialities like the energy and oil sector. Norway is also well prepared for the environmental monitoring applications, e.g. in the remote regions such as the Barents Sea. However, the pivotal weaknesses were uncertain supply of ICTs and other components, and too little public focus on the production industry, which is visible in the directions of funding. Key opportunities were environmental ICT applications,

especially in the Barents Sea, and ICT applications for the oil and gas market segments. In addition, industry's close links with the political system was seen as an opportunity in the workshop. The important threats were too little variety in state-of-the-art developments and lack of political attention to the production industry.

Table 9. Norwegian SWOT on ICT production.

Strengths	**W**eaknesses
• Manpower costs competitive for development • Stable manpower • High degree of automation • Willingness to adapt new methods • State-of-the-art products • Well-developed clusters in ICT production • Niche products based on products for Norwegian specialities • Short distance and good knowledge of home market • Well positioned for the coming development of the Arctic/Barents Sea	• Uncertain supply of ICTs and other components • Cost structure not competitive in relation to e.g. Asia • Few people, difficulties in handling large changes • Small geographic mobility • Little public focus on goods producing industry
Opportunities	**T**hreats
• More complex products with higher value • Application-specific products will rise in importance • Outsourcing of non-critical parts • Production must satisfy environmental requirements • Use of ICT in the Barents sea • ICT products specialized for the oil and gas market • Use the national expertise globally • Close links to the politicians • Wealth of the Norwegian society	• Increased competence, R&D and production in Asia • Difficulties to being state-of-the-art in all necessary fields • Not enough information about the near future • Heavy metals and brominated flame retardants • Lack of qualified people • Lack of focus on production education • Less political attention to manufacturing • Limited effort to maximize the use of State aid rules

The SWOT on security is presented in Table 10. The strengths in this theme were a well-developed research network, trust in authorities and, therefore, ease in the testing of new items. The weaknesses were the issue that Norway is not a member of the EU, which sometimes makes the cooperation tricky, and the quite limited experience in the security field. Opportunities were to be found in the security applications related to the gas and oil industry, i.e. the protection of critical infrastructures in the remote regions. Thus sensor systems provide a potential field for development. The pivotal threats were the basic lack of trust in the idea of ICT security, and lack of standards, legislation and regulation. In Norway, there is a limited amount of public funding in the field as well as fragmented political views on how to proceed with these issues.

Table 10. Norwegian SWOT on security.

Strengths	**W**eaknesses
• High competence in Nordic countries • Well-developed research network • Similarities of Scandinavian languages • Fundamental trust in authorities and easy to test new items • Norway is "defined" as low risk and has international trust • Large well-reputed RTO (both Norway and Finland)	• Norway is not a member of the EU; sometimes makes it difficult to take part in collaboration in the EU • There is only welfare, no crisis in Norwegian society • Norway has little expertise in the security field
Opportunities	**T**hreats
• Increased terror, criminality and other misery • The North Sea and the Barents Sea, i.e. everything related to gas and oil industry • Increased penetration of ICT in all areas • Few off-the-shelf products • Strong collaboration between NGOs and authorities – export of security solutions • Global markets • Defence • Common administration of wild life in the Nordic countries • Education on how to behave on the Internet • Sensor systems for surveillance/security • Control systems for critical infrastructure	• Global competition • New innovative solutions from EU and US • People do not buy the idea of ICT security – unrealistic to believe that ICT can solve all opportunities related to safety and security • Organised crime • Lack of standards • Shortcomings in laws, both old laws and lack of regulations in new • Changes in common attitude to personal protection • Limited stimulation from public administration – both projects and funding • Fragmented political views > diffused competences in the theme

4.2.4 Danish variation

The Danish SWOT analysis was carried out via four small workshops that handled the Nordic ICT Foresight themes in turn: experience economy, health, production economy and security.

The Danish SWOT on the experience economy is presented in Table 11. The defined strengths were Danish competences in making combinations of old technologies towards new and innovative solutions – this ability to utilize the second or third wave of innovations is sometimes called the "Danish model". In Denmark there is also a strong tradition in design, art and architecture. One of the Danish features of the experience economy is the competency in the field of sound. Further strengths are the social competencies of co-operation and project management. There is crucial potential in the fields of film, gaming and tourism, as well as establishing conferences. Weaknesses in the theme were the lack of large "locomotive" companies, the dispersed definition of the area of the experience economy – the present definition is spread over 100 lines of business – a lack of mobility between research and the business environment, and non-

growth-oriented small firms. The identified key opportunities were based on Denmark as a competitive "brand", the capacities to combine different public, private and civil actors, and potential growth trajectories in movies and games. The identified crucial threats were the threat of global competition and one-directional partnerships with some key players in the field.

Table 11. The Danish SWOT on the experience economy.

Strengths	**W**eaknesses
• Strong political – both government and local authority – focus and willingness to support the building of a good ICT infrastructure • Scientific and business awareness and interest in the area • High educational level and a high degree of access to ICT • Strong tradition in design, art and architecture • Large segment of creative people and technology freaks • Good social competencies in co-operation and project management • World-class competencies in the field of sound • Potential growth areas in the fields of film, gaming, tourism and conferences • Tradition for making new combinations of old technology into new and innovative solutions • A national brand as a safe and sound country	• Lack of big companies as engines of innovation and growth • The home market is small • Investments are spread and not focused • No clear definition of the area (the present definition is spread over 100 lines of business) • Lack of cultural competencies among investors • Lack of mobility between research and business environment • Many small firms that are not growth-oriented • Lack of information and communication of legislative rights • Not technology-leading • Habitual thinking within the innovation environments • Need for strong and charismatic leaders and professional boards
Opportunities	**T**hreats
• Denmark as a competitive "brand" (pre. Jyllands Posten) • Continue to build on the mix of public, private and civil society as a "non-Disney" business strategy • Potential areas of growth in movies and games • Strengthen international cooperation with technology leaders and form partnership with world-leading technology companies. We have the creative abilities, they have the technology • A general opportunity to strengthen business and profits • Creating a market for testing (for the American market)	• Foreign companies run with the commercial successes • Demand from Danish companies in international partnerships on total self-determination can block the way for further partnerships • Threat from the Eastern markets

The Danish SWOT on health is presented in Table 12. The special focus of the Danish version was eHealth. The most important strengths identified in the workshop were the user involvement in development and design processes, well developed cooperation between public and private organisations, and advanced technological infrastructure. The key weaknesses were considered to be the administrative split between two administrative systems (rehabilitation and prevention), short-term thinking, lack of continuity in the political programmes and initiatives, lack of courage and commitment to follow the groundbreaking

visions. A further weakness is the fact that in the research-driven field the publications are generally rewarded but not the development and practical implementation. The crucial opportunities were the following: increasing the speed with which successful research results are implemented in practice, increasing the utilisation of existing data and enhancing the cross-scientific "fertilisation" between different branches. The most important threats are lack of public investments in education and R&D, and too much emphasis on publicising research results.

Table 12. The Danish SWOT on eHealth.

Strengths	**W**eaknesses
• User involvement in development and design processes • CPR numbers and a well developed praxis of registration • Good IT networks within healthcare (fiber optics) • Relatively few old and "non-functional" ICT EPJ systems • Relatively strong international position on EPJ • A strong focus on healthcare standards and terminologies (SNO-MED) • Well developed cooperation between public and private organisations • Strong research competencies within CSCW • Healthcare system is run by government	• Initiatives related to prevention rehabilitation are split between two different administrative systems • Short-term thinking • Sub-optimisation • Lack of continuity and coherence in the political programmes and initiatives • Traditionally, the geographic conditions of Denmark have given very few incentives for traditional telemedicine • Lack of courage and commitment to follow the groundbreaking visions • Lack of education on ICT in the healthcare educational system • Very few career incentives for doctors are related to the development of new ICT systems • Publications are rewarded but not development and implementation • The hospitals' architectural choice makes implementation of ICT solutions difficult
Opportunities	**T**hreats
• Increase the speed with which the successful research is implemented in practice • Increase the focus on IT systems that may reap the benefits of data that already exists digitally • Support the development and implementation of the national EPJ (G-EPJ) • Enhance the possibilities for students and researchers to work across traditional professional boundaries between natural sciences, health sciences and social sciences. Promote the positive examples of this practice • Increase the understanding and respect between the different professional areas • Increase the central powerbase for central authorities to implement EPJ initiatives • Develop the professional networks	• Short-term focus on the policies related to the area • Worldwide recession • Lack of good ICT employees • Lack of public investments in education and R&D • Xenophobic development will have a bad influence on the knowledge economy • Too much focus on publication from the researchers and too little focus on implementation • Poor communication of the results of research

In the Danish SWOT on the production economy (Table 13) the pivotal identified strength was a flexible and SME-based industry structure that is willing to adopt new solutions. In Denmark, the robot industry and motion

planning is a particularly strong sector. The Danish robot cluster is based on user-driven innovation and a competitive cost structure. In Denmark there are also significant competencies in sensor technologies. In addition, employer unions endorse the utilisation of automation and robots in industry. The important weaknesses are short-term investment strategies due to the small size of the firms. The research spearheads are in quite narrow sectors with a limited amount of critical mass. There are also too few large firms to act as drivers of technology development. In the lack of larger firms, the public sector acts as the key driver in the production economy. That is also the first opportunity identified by the Danish SWOT workshop. Robots for niche markets, like robots for consumers and low-cost robots for specific industrial purposes, could be further opportunities for Denmark. In addition, demands on industry to renew products, to produce smaller series and engage in flexible production opens up opportunities for cheap software-based robots. The essential threats are the lack of a national strategy and new emerging developments in the sector.

Table 13. The Danish SWOT on the production economy.

Strengths	**W**eaknesses
• Flexible industry structure with a large segment of SMEs • A willingness to adapt and change in the industry, and a demand for flexible solutions among SMEs • Strong research communities within motion planning and flexibility planning for robots • Strong research community within OLP network offline programming • General ability to think in flexible solutions and user-centred innovation • Robot cluster with a geographical concentration and competencies • More than 20% lower costs than the average at an acceptable quality level • High integration among solutions made up by different technology components • High education level, e.g. within sensors and production • Workers and employers unions that support further use of automation and robots	• Many SMEs with short-term investments and small investment budgets • Many SMEs with employees with less competencies than workers in competing countries • Most research communities are leading in very narrow areas but do not all have a size to give a critical mass • Too few large companies and industries to drive technology • Improvements only in technology and applications, not in strategic technology programmes • Lack of leadership and technical competencies in production • Many SMEs means little risk and venture capital
Opportunities	**T**hreats
• Public sector as a driver • Development of service robots gives opportunities because technology will be available for SMEs within 10 years • Robots for consumers is an open market and gives opportunities for Danish-made robots • Low-cost robots for specific uses • Demand in industry to renew products, make smaller series and flexible production opens up opportunities for cheaper and flexible software-based robots • Further aim at developing and exploiting strong research positions (based on market analysis)	• Larger robot countries with large industries will take over developments in our small research communities and SMEs • Little production left in Denmark • Sparse investments in Denmark and Europe • No focus in the Danish strategy • No larger aim, strategy and money for radical and path-breaking innovations and developments

The Danish SWOT on general ICT security is shown in Table 14. The critical strength of the Danish system was quite well defined laws on privacy. The weaknesses were the lack of user understanding, lack of transparency in dataflow and challenges in the creation of software for secure transactions. The opportunities are to be found in engaging SMEs in the development of ICT security, standardisation and certification of software, and in the establishment of risk assessments for the clients. In general, it was acknowledged that a public discussion on the systemic "unseeable" technological developments should be encouraged. The most important threats are lack of public discussion relating to access and use of citizens' information and organised crime and terror[1].

Table 14. The Danish SWOT on general ICT security.

Strengths	**W**eaknesses
• Laws related to privacy are all in place	• Lack of user understanding • Lack of transparency in dataflow • Software challenges related to secure clients • Error 40
Opportunities	**T**hreats
• Engage SMEs in IT security • Learn to discuss things unseeable by the public • Standardisation and certification of software • Establish opportunities risk assessment for the clients	• Lack of public discussion relating to access and use of citizens' information • Organised crime and terror (e.g. Jyllands Posten)

The last Danish SWOT, on ICT security, research and business, is presented in Table 15. The most important current strengths were found in cryptography, digital ID and ICT security developments in healthcare. The key weaknesses were, somewhat reversing the strengths, too strong a national focus on cryptography, lack of cooperation and knowledge sharing between universities and the dependence on global software producers. The pivotal opportunities are to be found in the research projects that combine universities and companies, research on the strategic dimensions of ICT and ID management, and in the integration of biometrics in products. The crucial threats emphasise the finding of a balance between the demands and opportunities for companies engaged in ICT security, the lack of international orientation and the lack of studies that show the benefits of ICT security.

[1] It should be noted that the Danish SWOT was made in the period when the so-called Jyllands Posten case was being discussed in public.

Table 15. The Danish SWOT on ICT security, research and business.

Strengths	**W**eaknesses
• The wide spread of ICT means that many are concerned with security issues • Cryptography • Digital ID • Healthcare and IT security	• Too strong a focus on cryptography • Not much production • Lack of knowledge sharing between universities • Dependence on software producers
Opportunities	**T**hreats
• Research project where universities and companies meet • Research on the economic and strategic dimension of ICT • Create international liaisons • IT security in the curriculum of a growing number of education institutes • Public organisations must push the market • Research on software and tools to support financial transactions • Research on the use of ID management • Integration of biometrics in products	• Strike the right balance between demands and opportunities for companies in relation to IT security • Lack of international orientation • Lack of investments • Difficult to attract students to the subject • Lack of studies that show the benefits of ICT security

4.3 Nordic level summary SWOTs

The national SWOT analyses produced some varied results for each country. In this chapter the key similarities and differences of the national trajectories are condensed in order to give some flavour of the potentials in the ICT landscape on the Nordic level. It should be remembered that the interpretations are based on the SWOT analyses above and thus give a partial picture of the situation based on the evaluation by some national experts.

The Nordic level summary of the experience economy is presented in Table 16. The combined Nordic strengths are similarities in ICT infrastructures, the existence of globally competitive ICT players and clusters in the region and utilisation of mobile technologies and applications. In the Nordic region there are advanced markets and users, and the new products are easy to pilot. People and regional communes in the Nordic countries are, in general, quite willing to adopt new things. The Nordic countries have strong national R&D systems and strong national investments in certain ICT fields. Thus the IPR and patent base is also robust, considering the relative size of the Nordic population on the global level. The key weakness in the experience economy on the Nordic level emphasises the weak capacity to build commercial solutions from technological developments. It can be stated that Nordic actors are quite small and there's a

need to build networks for the creation of critical mass. There is also a shortage of risk funding, although the recent Finnish Technology Barometer (Lehtoranta et al. 2007) states that in Finland the number of business angels is on a slight relative rise. One Nordic element might be the unclear division of labour between governmental organisations. In addition, if the Nordic cooperation is to be intensified, there is a strong need for evidence of the benefits of the Nordic cooperation. The last combined weaknesses describe the common technologically oriented development culture in the Nordic countries. Albeit development is too technology driven, there are still development gaps in some technologies, such as fuel cells.

The Nordic opportunities and development potential in the experience economy are many (Table 16). The most promising potential is in the development of user centred open innovation processes. This could include the utilisation and targeting of the "long tail" aptly coined by Anderson (2004 & 2006). The long tail refers to the number of small and varied niches that exist in, for example, the music industry's fragmented consumer markets. There is also potential in the creation of Nordic SME-based competence clusters in some niche areas, e.g. in mobile applications. There are opportunities in the integration of education and information technology competencies, e.g. in the fields of navigation and control of health information. This might open up possibilities for the formation of "hybrid knowledge" at the cross-sections of different sciences, businesses and design branches. Moreover, the fact that the Nordic countries are quite sparsely populated and all of the Nordic countries, maybe excluding Denmark, contain large peripheral national regions create opportunities in ICTs. The vast territories could be utilised as an advantage to develop cost-effective data transmission formats and solutions. This idea could also be utilised to create unique knowledge of ICT-driven remote sensing systems to monitor peripheral areas, e.g. the Barents Sea. The threats to the Nordic experience economy mainly come from the international competition landscape, especially the development of Asian R&D competencies. The notion that a large segment of Nordic ICT firms – and also firms in other sectors – are not growth-oriented brings hindrances to the formation of new jobs. There is also a lack of Nordic level and global perspectives among the SMEs in the region. In addition, rigidities exist in the cooperation between different societal spheres, e.g. sciences, governments and businesses. Furthermore, lack of new business models and concepts is a threat that could have considerable effects in the longer term.

Table 16. Nordic level summary SWOT on experience economy.

Strengths	**W**eaknesses
• Similarities in ICT infrastructures • Advanced globally competitive players and clusters in production ICTs • Advanced mobile technologies and applications • Advanced markets and users: new products are easy to pilot • IPR and patent base • Strong national R&D systems • People and regional communes are willing to adopt new things • Strong national investments in certain ICT fields	• The capacity to build commercial concepts from technological developments • Too many small players > need for Nordic networking to build critical mass • Lack of risk private risk funding • Deficiencies in the division of labour between different governmental organisations • In some areas there is a lack of evidence-based information about the benefits of Nordic cooperation • Development culture is technologically oriented • Gaps in some technological niches, e.g. screen technologies, fuel cells
Opportunities	**T**hreats
• Developing user-centred open innovation processes • Creation of Nordic SME-based competence clusters in niche areas • Integration of education and information technology competencies, e.g. navigation, control of health information • Advanced knowledge in cost-effective data transmission > Nordic countries sparsely populated • Utilisation of knowledge of ICT infrastructures and remote sensing systems for remote environmental monitoring in peripheral areas, e.g. Barents Sea • Hybrid knowledge > combinations of different sciences and businesses • Combination of technology and design competencies	• International competition • Large segment of Nordic ICT firms are not growth-oriented • Strengthening R&D competencies in Asia • Rigidities in the cooperation of different sectors: sciences, governments and businesses • No clear Nordic vision of the cooperation benefits for different actors • Lack of global perspective • Lack of new business models and concepts

The Nordic level summary SWOT on health is presented in Table 17. The Nordic strengths in health are advanced basic research and R&D in biotechnology and medical sciences. The Nordic health infrastructures are advanced and quite alike. There are strong niches in ICT health applications, e.g. biotechnology and sensors, besides the traditional cooperation between public and private actors in the Nordic countries. The Nordic countries have advanced national innovation systems in health ICT applications. The Nordic weaknesses in health are mainly in the capacities to build commercial concepts from technological developments. Although the innovation system is working in a quite effective way, there are some critical limitations in resources, especially in adapting new eHealth solutions in practice and education. This also reflects another "hole" in funding, namely the lack of private risk funding. Two kinds of risk funding are required: 1) long-term "slow" funds and 2) more short-term experimental funds. The Nordic level opportunities in health are coiled around the idea of the formation of a common Nordic test market for health applications. It is also important to develop user-friendly interfaces, especially

for the needs of the aging population. However, it should be remembered that some elderly people have ICT capabilities to act as advanced early adopters. The Nordic countries have huge potential in developing advanced mobile applications in health. Focusing might also be a key opportunity – the Nordic countries could focus, for example, on some eHealth niches and aim at global markets in these niches. The threats in the health sector can be wrapped up in the following way: the key threat is the lack of a visionary view, i.e. the benefits of health developments are usually seen through a narrow local perspective and in a too short time span. The health sector is fragmented; there are many actors and interest groups. This creates an unclear view about the division of labour in the health sector. There are also crucial rigidities in the cooperation between universities, governmental organisations and firms. It is also important to realise that a considerable proportion of the aging population cannot cope with the new technological solutions. The final Nordic level threat lies in the regulation that runs way behind the fast-running health applications.

Table 17. Nordic level summary SWOT on health.

Strengths	**W**eaknesses
• Advanced basic research and R&D in biotechnology and medical sciences • Advanced and quite similar health infrastructures • Strong niches in ICT health applications, e.g. biotechnology and sensors • Strong national innovation systems on health ICT applications > Nordic governments advanced in the financing of health applications • Good cooperation between public and private actors	• Capacity to build commercial concepts from technological developments • Non-compatibility of European, national and local regulations • Limited resources > the capacity to adapt new eHealth solutions in practice and education • Lack of risk private risk funding. Need for two kinds of funding; 1) long-term "slow" funds and 2) more short-term experimental funds • Some critical fragmentations in health system on national and Nordic levels
Opportunities	**T**hreats
• Common Nordic test market for health applications > to adopt Nordic view on health applications • Creation of user-friendly interfaces for the aging population > some elderly people could be early adopters • Adapting advanced mobile applications in health • Creating strong competencies in some eHealth niches and exporting the applications globally • Hybrid knowledge > combining different branches, e.g. sciences and businesses	• Seeing the benefits of health developments in a too narrow sense and a too short time span • Unclear division of labour and responsibilities in health sector > many actors and interest groups • Regulation runs behind the potential applications • Rigidities in the cooperation between different sectors: universities, governmental organisations and firms • Considerable proportion of aging population cannot cope with new technological solutions • Lack of global perspective

The Nordic level summary on production economy is shown in Table 18. The strengths on the Nordic level are advanced markets and advanced users. The ICT competencies in the production economy are strong, especially in simulation,

telecommunications, IP and mobile applications. General ICT literacy on the industrial level is strong. Besides, there are complementarities to be found in the diversity of the production economy in the Nordic countries. The crucial weakness in the production economy application is the weak capacity to build commercial concepts from technological designs. Standardisation and a lack of private risk funding are also seen as crucial weaknesses. Utilisation of ICTs in the production economy is too focused on actual production functions. ICT application could be used more widely in the ideation and commercialisation phases. Furthermore, there is one clearly stated Nordic weakness: the difficulty in attracting new students to grass root production areas.

The Nordic opportunities in the production economy are in the search for complementarities in the diverse Nordic production base and, therefore, in the creation of cross-cutting applications. Another opportunity is to utilise Nordic ICT competencies in the creation of user-friendly and adaptable interfaces for different production systems. Opportunities are also to be found in the development of ICT applications for the production chain as a whole: ICTs could be more widely utilised in ideation, concept formation, production, logistics and marketing. Other niche opportunities are to be found in the development of simulation software and applications and in adopting advanced mobile applications in the production economy. In addition, the adoption of ICT applications in SMEs could be more broadly supported. The Nordic level threats in the production economy culminate in the lack of Nordic level visions on the theme that is shared with key stakeholders. International competition, especially from Asia, forms a critical threat. The effects of international competition are also seen in the globalising ownership structure of Nordic firms. In the long term this could affect the direction of foreign direct investments.

Table 18. Nordic level summary SWOT on the production economy.

Strengths	**W**eaknesses
• Advanced markets and users: new products are easy to pilot • ICT competencies in production economy are strong: simulation, telecom, IP, mobile • ICT literacy in industries is generally strong • Diversity > Nordic countries have different specialities in production economy	• Capacity to build commercial concepts from technological developments • The utilisation of ICTs in the production economy is too focused on actual production functions • Standardisation • Lack of private risk funding • Difficulties in attracting new students to grass root production
Opportunities	**T**hreats
• Search for complementarities in diverse Nordic production base and create cross-cutting applications • Creation of user-friendly and adaptable interfaces for different production systems • Developing ICT applications for the whole production chain > ICTs could be utilised in ideation, concept formation, production, logistics and marketing • To support SMEs in ICT applications • Development of simulation software and applications • Adapting advanced mobile applications in production economy • Hybrid knowledge > combinations of different sciences and businesses	• No clear Nordic vision • Globalising ownership structure in firms and its effect on the national investments • International competition • Strengthening R&D competencies in Asia • Rigidities in the cooperation between different sectors: sciences, governments and businesses

The last summary SWOT, on security, is presented in Table 19. The Nordic level strengths are well developed research networks, competencies in cryptography, many advanced business players in ICT security and advanced competencies in security technologies, e.g. in surveillance. The crucial weakness, as in all the previous SWOTs, is also focused on the capacity to build commercial concepts from developed technologies. In addition, the Nordic players are quite small and in need of private risk funding. In short, industry is still somewhat underdeveloped. Security is also dependent on global software producers. Moreover, the user perspective, e.g. in interfaces, could be developed further. The Nordic region has much potential in the field of security. For example, R&D on ID management and biometrics could be important opportunities. ICT security applied in health forms an important opportunity. There is also potential in the creation of tools for secure financial transactions, mobile applications in security and engaging in standardisation of software solutions. The large number of players with complementary competencies in the field provides a good starting point. Furthermore, there are possibilities in the different larger topics, such as ICT applications in environmental security, i.e. in the Baltic Sea, North Sea, Barents Sea and in the applications built on networked

defence concepts. Interesting opportunities might also rise from the fact that the images of threat are somewhat dissimilar between the Nordic countries and provide a quite wide understanding of security. However, there are some threats in the field. One key threat is that there is not enough public discussion on the consequences of ICT security. There is also a need for further knowledge about the benefits ICT security, especially for the SMEs. Lack of standards creates a threat, as well as regulation, which is lagging way behind the potential applications and potential needs of the customers. A wider threat might be the fact that security is usually approached as an obligatory need rather than a business opportunity.

Table 19. Nordic level summary SWOT on security.

Strengths	**W**eaknesses
• Research networks well developed • Cryptography • Advanced business in ICT security • Security technologies advanced, e.g. surveillance • Many players	• The capacity to build commercial concepts from technological developments • Lack of private risk funding • Players are quite small • Industry is still underdeveloped • Dependence on global software producers • User perspective underdeveloped
Opportunities	**T**hreats
• R&D on ID management (e.g. DRM, biometrics) • ICT security in health • R&D on tools to secure financial transactions • Standardisation of software solutions • Adapting advanced mobile applications in security • ICT and environmental security (Baltic Sea, North Sea, Barents Sea) • Competences in networked defence concepts • Potential complementarities of many players • The images of threat quite dissimilar between the countries > large understanding of security	• Not enough public discussion on the consequences of ICT security • Lack of studies on the benefits of ICT security • Organised crime • Lack of standards • Technological development way ahead of regulation and legislation • Security is approached as an obligatory need, not as a business opportunity

5. Emerging ICT trajectories

5.1 ICT themes in Nordic ICT Foresight

Nordic ICT Foresight emphasises four themes in ICT adoption: experience economy, health, production economy and security. *Experience economy* widely covers the media, communication and entertainment applications of ICT. It touches upon such themes as mobility, content digitalisation, new terminals, user interface development and user-generated content. *Health* emphasises the consequences of ICTs in the health sector and discusses such issues as health information systems, document distribution, storing and management, data organisation, health consultation, self-medication, home care and support for the elderly. *Production economy* considers the ICT applications in the production industries. In the production economy theme, such topics as Internet-based information systems, logistics, industrial sensor systems, automation and energy infrastructure are of importance. In the fourth theme, *security*, the focus is on security in general and in information security. Security in general covers issues such as general crisis management, natural catastrophes, prediction and prevention of external and internal infrastructural crises. In information security the important issues are confidentiality, management of user identities and secure electronic transactions. Such issues as intelligent traffic systems are also covered in this theme.

The emerging ICT trajectories were identified and discussed in the emerging technologies workshop held at VTT in December 2005 (see Appendix A). The following list of emerging technologies was gathered as background for the work (Table 20). The material was organised around the emphases of the Nordic ICT Foresight (experience economy, healthcare, production economy and industrial systems, and information security). In experience economy the most important emerging technologies can be grouped around five general themes: personally tailored communication and media services, network technologies and solutions, ambient intelligence and ubiquitous computing, multi-channelled devices and new technological solutions. In healthcare the following five general categories were the most important: bio-information systems, ICT-based healthcare support systems, simulation and visualisation, health consultation and telemedicine. In production systems the reports emphasise field devices, new control systems,

new analysis systems and evolving user interfaces. In information security the central solutions are trustable and secure information systems, link security, biometric information and different kinds of embedded security solutions.

Table 20. Examples of the emerging technologies and emergent technological concepts in ICT (Alahuhta et al. 2004, Sipilä 2002, Ventä 2004, Lucenius et al. 2004).

Experience economy	Healthcare	Production economy	Information security
• **Personally tailored communication and media services**: ubi-services, intelligent agents, distributed data storage and information search... • **Network technologies and solutions**: peer-to-peer, parallel networks, sensor networks… • **Ambient intelligence and ubiquitous computing** • **Compatible, multi-channelled devices**: convergence, heterogeneous networks, ad hoc, context awareness… • **New technological solutions**: 3D screens, flexible screens, fuel cell batteries...	• **Bioinformatics, bio-information systems and databanks**: extensive biological datasets, data mining, interactions • **ICT-based support systems for healthcare**: e.g. diabetes, blood pressure, targeting and dosing of medicines, "home medicine" • **Simulation and visualisation**: e.g. system biological interactions, protein research, virtual models… • **Health consultation**: the gathering of knowledge to support decision making • **Tele, virtual and distance medicine**: e.g. samples from Paris, analysis in Helsinki, diagnosis in New York, technical writing in New Delhi	• **Field devices**: e.g. sensor fusion, sensor actuator smart devices… • **Control systems**: e.g. modularity, flexible architectures, design tools, advanced algorithms, unexpected situation management • **New analysis systems and user interfaces**: e.g. mobile terminals, fault navigation tools, abnormal situation management tools, visualisation, knowledge management, lifecycle management, performance indicators, simulation, intelligent agents…	• **Trustable and secure information systems**: eavesdropping, scanning of private information, unauthorised access, "man-in-the-middle", system breakdown, trojan horses, backdoors... • **Security on the level of links and networks**: information security protocols, secure information flows, authentication, security in the mobile and heterogeneous networks... • **Biometric information in digital form** • **Security and filtering solutions embedded in telecommunication infrastructure**: DRM, SPAM, virus...

The method for the identification of the most important applications and generic technologies was divided into three phases (Figure 8). The idea was to define applications and generic technologies according to the Nordic ICT Foresight emphases. The formal process of the identification of generic technologies and applications was the following:

- identification of the applications according to the Nordic ICT Foresight emphases (experience economy, health, production economy, security), ten-year time frame

- three applications per emphasis area
- two working groups
- defining the basic applications: participants listed three most important applications
- prioritization: evaluation of the three most important applications through group discussion and voting.

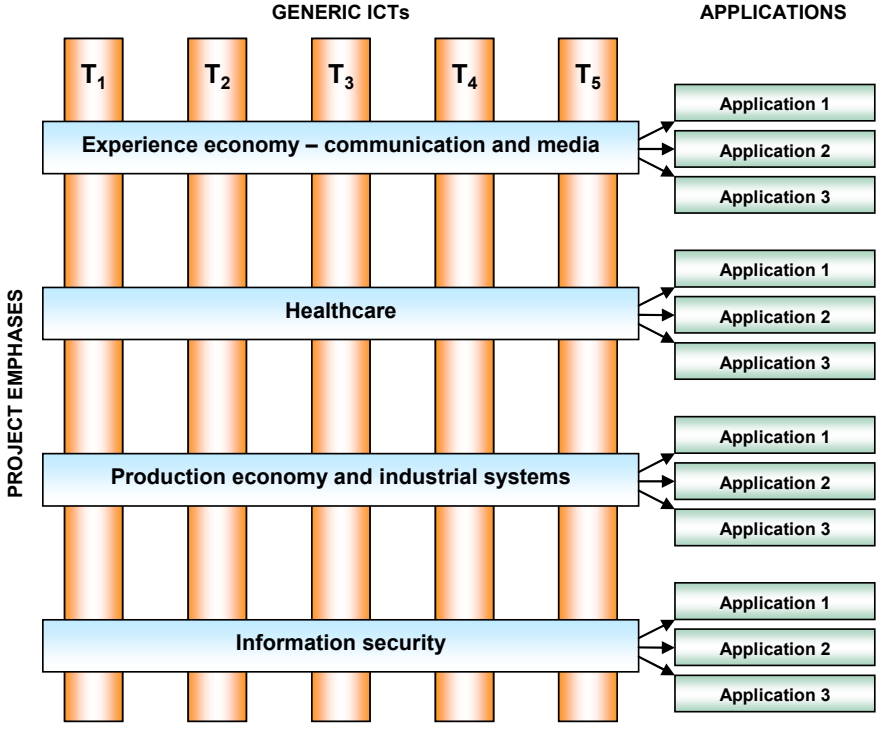


Figure 8. Generic ICTs, applications and Nordic ICT Foresight project structure.

5.2 Emerging applications

In the following chapters the results of the emerging technologies workshop are collected under the four emphases of the project: experience economy, healthcare, production economy and information security (see Ahlqvist 2006a). The results are presented in two complementary groups reflecting the discussion groups in the workshop.

5.2.1 Experience economy

Group 1. The most important ICT applications can be categorised into four classes: tailored service applications, network applications, voice and language-oriented applications and ubiquitous technologies (Table 21[2]). In *tailored service applications* the questions of personally tailored information control and digital identity was heavily debated. These solutions enable utilisation of information resources independently of a certain device. There was quite a lot of talk about virtual personality, e.g. avatars, and agent technologies that could enable the mobilisation and moulding of virtual personalities. The key question relates to devices that automatically communicate with each other, e.g. by utilising agent technologies. Another set of issues was personally tailored media chains, where the user can make personal "value chains": buy certain services here and certain services there. Therefore, the user can tailor the content and price of the service according to her/his own needs and desires. These kinds of services can also be utilised on the communal level, i.e. a certain group of users can tailor their own media value chains. More widely, it is a question of a user-centred innovation process where the users act as "directors". Tailoring can be also done automatically, e.g. by an application that tailors the services according to certain common characteristics of the users.

The second set of the experience economy applications was *network technologies*. The workshop discussion wandered around the questions of ad hoc and heterogeneous networks. The question of content delivery through open networks and the different solutions enabling different content services was also a focal issue. According to the workshop discussions, the key application in the open networks should be based around neural networks or a semantic web. *Voice and language-oriented applications* was the third category under discussion. Different simultaneous translation applications were estimated to be especially crucial in the future. Different voice controlled systems could be utilised for travelling and different information purposes. The fourth category in the experience economy was *ubiquitous technologies*. The notions of virtual presence and ambient design were seen as potential sources of applications in the future. The key innovation lies in the utilisation of many senses at the same

[2] The number in brackets represents the weight of the description: the higher the number, the higher the weight.

time. For example, ambient design could be utilised in multi-sensory marketing, utilising more than just visual sensation.

Table 21. Emerging experience economy applications – group 1. The number in brackets represents the weighted value of the discussion topic.

Experience economy / Group 1
Tailored service applications
• ***Personal information control***: communication and identity independent of the device • ***Digital identity*** • ***Personal media production***: personal value chain, real-time production • ***Community-based information solutions*** • ***Bi-directional media services***: informing, teaching, "users as innovators"
Network applications
• ***Content delivery through networks***: peer-to-peer • ***Compatibility of networks*** • ***Intelligent information search and organization techniques***: e.g. based on neural networks
Voice and language-oriented applications
• ***Applications of language technologies*** • ***Multilingual solutions*** (travelling, informing, speech recognition)
Ubiquitous technologies
• ***Ubi-intelligence***: techniques of virtual presence • ***Ambient Design***: multiple senses, marketing

Group 2. The most important ICT applications can be divided into six categories: hybrid media, communication services, voice and language-oriented applications, technical solutions, virtual environments, and entertainment (Table 22). *Hybrid media* was the first category. The first theme of applications emphasised new kinds of combinations. In this theme the combination of printed and electronic media is crucial. One example is 2D code that is readable via a mobile cameraphone, which connects the mobile phone to a database. Other examples could be intelligent paper and intelligent packaging. Another application could be "talking paper", which combines sounds with still images. Tailored news is one further application. News could be either locally or personally tailored. News could be printed either to a communication device or by a local printing service, communal printing. The second category was *communication services*. Based on the workshop discussions, the development is going towards a global media network. In addition, the question of digital me (personal avatar in networks) is fundamental to networked communication services. Mobile ID-TV could be one rising solution (Korea and Japan are

benchmarks in this field). Group phone calls were seen as an important application, for example in organising meetings. There was also discussion of free services with different devices and the question of expression and performance of civil rights via networks (voting, taxes).

Third category was *voice and language-oriented applications*. In this category the simultaneous translation services became a hotspot of discussion. Simultaneous translation was estimated to be a plausible emerging application on the Nordic level. The fourth category of discussion was *technical solutions*. The most plausible applications discussed were printable electronics, RFID tags, silent computer and digital technology (without background noise or humming), and home robots. The fifth category was *virtual environments*. In this category the most important applications were home virtual environments, multi-sensory environments and virtual learning platforms. One key application is enhanced reality (or augmented reality), which refers to the combinations of virtual objects and real environments. For example, one could roam in ancient ruins equipped with augmented reality technology (glasses, garments, etc.) and see virtual models of the old buildings in their actual place. Another application is connected to entertainment: games of tomorrow could fuse reality and augmented reality in a sense that the player is moving in a real environment and, for example, chasing virtual objects. Augmented reality might be a key part of ubiquitous computing. The sixth category is *entertainment*. The discussion centred on "edutainment" concepts (games that combine education and entertainment) and games based on mobile positioning. These could be seen as one kind of augmented reality.

Table 22. Emerging experience economy applications – group 2. The number in brackets represents the weighted value of the discussion topic.

Experience economy / Group 2
Hybrid media (1)
• ***Combinations of printed and electronic media***: e.g. 2D code that is readable via a mobile cameraphone that connects the mobile phone to a database
• ***Intelligent paper and intelligent packaging***
• ***"Talking paper"***: sound + still image
• ***Tailored news***: printed to either a communication device or a local printing service (communal printing) **(2)**
Communication services
• ***Global media network***: you can see your favourite show anywhere
• ***Digital me***
• ***Mobile ID-TV***
• ***Group phone calls***
• ***Free services with different devices*** **(2)**
• ***Expression and performance of civil rights via networks*****:** voting, taxes **(2)**
Voice and language-oriented applications
• ***Simultaneous translation services (4)***
Technical solutions
• ***Printable electronics***
• ***Silent computer and digital technology***: without background noise or humming
• ***Home robots***
• ***RFID tags***
Virtual environments
• ***Home virtual environments***
• ***Enhanced reality*** **(1)**
• ***Multi-sensory environments and virtual learning platforms***
Entertainment (2)
• ***Games***
• ***"Edutainment"***
• ***Games based on mobile positioning***

5.2.2 Health

Group 1. The first and central category of the ICT applications in healthcare is the *personal healthcare* or "*home medicine*" (Table 23). The key applications in home medicine are systems that monitor, gather and analyse personal health information. The ICT system could warn about fluctuations in health, it could also keep up a training diary. Another set of home medicine applications is systems that monitor and enable the living of the disabled or elderly people. Monitoring systems are based on the concept of spatial control. The idea is similar to the "panopticon" that philosopher Foucault described in his essays: the

spaces accessible by the patient should be totally covered by sensors or other monitoring devices. Naturally, this idea brings forth quite far-reaching ethical issues and issues of personal and individual security. ICT applications could also be utilised in modular training devices that help the rehabilitation of the patients. The monitoring systems and modular training devices could also be combined in order to form eHealth and ePrevention structures where the system monitors, and makes prognoses and forecasts of, the patient's current status. This information is then directly connected to the lifestyle forecast that thrives to maximise the patient's health. In the context of the monitoring systems, the discussion in group 1 circled around the issue of interfaces. The nature of the interfaces is a crucial issue in monitoring systems. Interfaces could be executed in several ways: by sensors, by implantation or by wearing (for example alarm bracelets). The general tone of the discussion concluded that people are quite fixed with the current ideas of keyboard or visual-based interfaces. There was discussion about wearable gadgets and intelligent clothing.

Table 23. Emerging health applications – group 1. The number in brackets represents the weighted value of the discussion topic.

Health / Group 1
Personal healthcare, "home medicine" (8)
• ***Gathering and analysis of information***: diaries, training calendar, prevention **(6)**
• ***Systems that monitor and assist elderly people living at home***: controlling the changes in health, monitoring day-to-day activities **(2)**
• ***Technology-assisted training***: modular technologies
• ***Vital sign data capture / collection***
Diagnostic and treatment applications
• ***General ICT applications in health***: pattern recognition, ubi-computing, mobility, hybrid media, dosing...
• ***Nano / picosensors***
• ***ICT-based diet and nutrition systems***
• ***Chip laboratories***
• ***Virtual diagnostics, distance diagnostics*** **(2)**
Medical information processing
• ***eHealth & ePrevention****:* knowledge-based, data warehouses, data mining / drilling
• ***National health databases***

The second class was *diagnostic and treatment applications*. These applications included pattern recognition, dosing, and mobile solutions. Nano-scale sensors could change the diagnostic and treatment processes in radical ways. ICT applications could also serve as an infrastructure for treatment, in dosing,

nutrition and routine checks. Chip laboratories, and virtual and distance medicine, are central future ICT applications. The third class that was discussed could be labelled *medical information processing*. The discussion emphasised a coherent and convergent database that could be utilised by data mining and data drilling techniques. On the national scale, a database could serve as a data warehouse where one could load personal histories of the patients and make comparisons and analyses between larger numbers of cases. The first challenge is to integrate and unify the information systems. In addition, one should also consider the utilisation of the information. Is the information used for direct treatment, analysis or longer-term prevention? These perspectives all require different solutions.

Group 2. The central applications can be examined through four categories: "home medicine", assisting and socially activating technologies, applications for the control of allergies, and documentation applications (Table 24). "*Home medicine*" is probably the most pivotal application of ICTs in healthcare. Possible future applications for home medicine cover a wide landscape. Firstly, there are applications for self-treatment. There are self-service systems, different kinds of health centre and pharmacy systems, additional services, and "mobile service and competition" automata. The last of the applications was thought to be service, where the customer could choose the most cost-efficient medical solution. Secondly, there are *socially activating and assisting applications* that help the patient in everyday living. The applications that were anticipated in the workshop discussion were "every home" service robots and intelligent user-centred services for the senior housing. A more futuristic application is the brain interface, which could assist the seriously disabled in their homes. Thirdly, there are intelligent network systems that could turn the house into a real-time diagnostic system. The workshop discussion circled around the alarm systems that monitor the patient's condition in real time and, especially, in case of an emergency. There were also ideas about intelligent homes that could adapt to the inhabitants' health conditions. One application category estimated to be very plausible was the applications for the control of allergies. In this category the most efficient solutions would be linked to the prevention, diagnosis and self-treatment of allergies. One interesting category in the discussions was the advanced documentation applications. The question was about real-time documentation in the doctor's surgery. Documentation application could offer

records of the doctor's instructions, give crisp instructions on the net and as a print, and also guide the health client to sources of further information.

Table 24. Emerging health applications – group 2. The number in brackets represents the weighted value of the discussion topic.

Health / Group 2
"Home medicine"
• ***ICT home treatment***: free self-service systems, health centre and pharmacy systems, additional services, "mobile service and competition" automata **(5)**
• ***Adaptive, intelligent home***: conditions adapt to inhabitants' health conditions
• ***"Every home" service robots***
• ***Systems that monitor patient's condition in real time***: especially in the case of emergency (elderly people etc.), real-time diagnostics
Socially activating and assisting applications (5)
• **Brain interface**: for the seriously disabled
• ***Basic technology, tailored interfaces***
• ***Intelligent user-centred services for the senior housing***: technologies that activate everyday social contacts
Applications for the control of allergies (4)
• ***Prevention***
• ***Diagnosis***
• ***Self-treatment***
Documentation applications
• ***Documentation in the doctor's surgery***: records of the doctor's instructions on the net, crisp instructions on the net and as a print **(1)**

5.2.3 Production economy

Group 1. In the production economy, the key discussion topics in the emerging technology workshop can be categorized as new production applications, industrial information processing and control of the logistic chain (Table 25). In *industrial production applications*, the most important technologies in the future shorter term are the RFID applications and Internet-based production applications. Passive sensor technologies are a particularly important application area. These can be applied, for example, in environmental control, detection of gases, industrial process monitoring, and multi-sensing. The fourth application can be labelled learning devices – i.e. machines that monitor themselves automatically and learn to adapt to different situations. Learning devices are a first step towards the fully automatic factories that are one possible development

trajectory of the future. The last topic in the new production applications is more of a kind of overall goal, minimisation of production-related environmental hazards. The second category in the production economy is *industrial information processing*. The most important transformations will focus on the modes of information transfer on the axes of man2man, machine2man, man2machine. These are also related to new kinds of production control methods, e.g. sensor technologies and IP-based production solutions. Currently, the multi-directional data transfer between the actors – men and machines – is a problem. This problem will certainly magnify in mobile applications and, if solved in a user-friendly and effective fashion, is an emerging "killer application" in industrial production systems. The IP-based, device-independent communication could provide solutions to this problem. However, the basic dilemma is that different kinds of software are not compatible, i.e. different platforms are not communicating with each other. There are industrial process software (production, logistics, monitoring), mobile software, IP-based software, financial software, etc. These might all be based on different kinds of logic and, therefore, there are huge challenges in integrating them. Also, changes are going to occur in the methods and scope of information gathering. Information processing and gathering is going to happen in real time, synthesizing information on technology, market and financial developments.

The third theme discussed was *management of the logistic chain*, which emphasised information synthesis. An important application in this sense is the quality control and mobile maintenance. In this category, important emerging applications will be connected to the questions of production direction and mass customisation. Production processes will be more and more based on tailored and customised solutions between client and producer. This brings challenges to ICT applications on two levels. Firstly, one should be able to dynamically model the total production process from the very starting inputs (ideation and planning) to the final output (marketing and customer interface). Secondly, in order to be flexible, one should also be able to modify, alter and customise the bits and pieces of the process. Production processes should, therefore, be as modular as possible. The final theme in the discussion was the notion that basic technologies of industrial production are more path-dependent than in other emphases of the Nordic ICT Foresight project. This means that the ideas on integration and unification require radical changes and large investments. Besides, well-established actors might entrench this path dependence by sticking to old

production standards and, hence, affect the transformational capacities of smaller and not-so-established actors. Newer SMEs are, therefore, "forced" to deliver within the frameworks provided by the customer, even though the customer might not demand state-of-the-art solutions.

Table 25. Emerging production economy applications – group 1.

Production economy / Group 1
Industrial production applications
• ***Sensor technologies***: especially passive sensors • ***Applications of RFID*** (radio frequency identification) • ***IP-based (Internet Protocol) systems*** • ***Learning devices***: self-monitoring of machines • ***Fully automatic factories*** • ***Minimisation of production-related environmental hazards***
Industrial information processing
• ***Information and data transfer in production systems***: man2man, man2machine, machine2man • ***General information gathering***: technology, markets, financing...
Management of the logistic chain
• ***Gathering and analysing the process data in real time*** • ***Quality control*** • ***Mobile and automatic maintenance and repair***

Group 2. Applications in the production economy and industrial systems can be analysed in three categories: industrial production applications, convergence of information systems and simulation applications (Table 26). *Industrial production applications* is the first category. The central applications consist of mass-tailored production lines, which could intensify and rationalise the production by minimising storages. An important application is new kinds of interfaces, which could come in multiple shapes and functions. They could be tangible, wearable, or embedded. In the workshop there was also talk about process control and robotics turning into multi-sensory applications. In robotics and production process systems the important ICT applications are those that enable telework and mobile work. This theme also covers the mobile maintenance systems. Automatic reasoning systems, aiming towards error seeking and production optimisation, were also seen as key applications in the production economy. Different kinds of environmental measuring systems and services were also on the agenda. These include local security, "emission trading" and emission control.

The second category is the *convergence of information systems*. Convergence turns the production process into a smoothly fluctuating network of active modules. The vision is that the performing, controlling and packing of information is combined via sensors. Combined information is comparable with planned information in real time. Lifecycle systems are connected to this process. The production economy would run by integrating plans, actual processes and process evaluation through ICT applications. The third category is *simulation applications*. These applications consist of simulation of micro-level phenomena in different fields, e.g. electronics, nanotechnology, fabrication of medicines, and material technologies. Another application would be to combine 3D visualisation and simulation to the actual production process.

Table 26. Emerging production economy applications – group 2. The number in brackets represents the weighted value of the discussion topic.

Production economy / Group 2
Industrial production applications
• ***Mass-tailored production lines***: on-demand systems, no storages **(2)**
• ***New interfaces***: tangible, wearable, embedded **(4)**
• ***Multi-sensory process control and robotics*****:** input / output **(1)**
• ***Applications enabling telework and mobile work*** **(1)**
• ***Mobile maintenance systems*** **(1)**
• ***Automatic reasoning systems***: error seeking, production optimisation
• ***Environmental measuring systems and service*****s:** security, "emission trading" and emission control **(2)**
Convergence of information systems
• ***Convergence of information***: the performing, controlling and packing of information is combined via sensors, then combined information moves to be compared with planned information **(1)**
• ***Convergence of all of the lifecycle systems*** **(3)**
Simulation applications
• **Simulation of micro-level phenomena in different fields**: electronics, nanotechnology, fabrication of medicines, material technologies **(2)**
• **Combination of 3D visualisation and simulation**

5.2.4 Security

Group 1. The workshop discussion on the emphasis of information security can also be categorized in three themes (Table 27). The first category is called

confidentiality in general. The discussed key philosophical question is to consider what information security will mean in 10 years' time. The whole concept might change into something totally different to what it is today. The key to this dilemma is to consider the different meanings of information. Information in ICTs will be understood more and more as contextual phenomena, not just as an abstract particle based on a principle of 1/0. Additionally, ontological structures in information management might change: files might not be the system through which information is managed in 2015. For example, Lanier (2002) talks about "information legacies", contextually changing and evolving information trajectories that might break the old file-based system. The most important applications identified in the workshop were those of identity management and dynamic privilege management. It was emphasised that the identities and privileges do not refer just to humans, but all the entities in the information space (e.g. humans, intelligent agents, programs, messages, codes, modules, devices). Identity and privilege management is pivotal in mobile and device-independent heterogeneous and ad hoc networks. The key question is how to manage identities in overlapping and technologically multi-dimensional solutions without being in danger of eavesdropping or message interception. In dynamic identity and privilege management the question is also about data integrity and the general trustworthiness of the actors providing security services. An important application in general information confidentiality is long-term preservation of the data. The problem can be stated as how to ensure preservation and confidentiality in technologically multi-dimensional networks where the control is organised around flexible distribution of fragmented information. How to connect the distributed information in a safe way? Where to store the pieces of information without slowing or "icing" the system? One way to ensure safety and confidentiality is to develop non-reproducing technologies.

The second category discussed in the workshop was *security in environments and networks*. Two applications were considered to be important. Firstly, new kinds of control models for open spaces. These could, for example, be based on sensor networks. Secondly, "invisible" information security. As was discussed, the general aim of the information security developments should be the creation of "invisible" systems, i.e. systems that secure the information channels without the specific attention of the user. The idea is that information security procedures should run "silently" in the background. The user does not have to be aware of

the constant security checks. These kinds of "silent" security applications should also be reflected from the societal perspectives. Systems should not enable, and the laws regulating these systems should not allow, any eavesdropping or ad hoc "witch hunting" by any of the actors. These kinds of activities, if realised, are a serious threat to the general confidentiality of the ad hoc networks and could limit their applicability. The third, and highly important, category is the security applications based on *biometrics*. Biometric security refers to the applications utilising biological characteristics as the basis of identity and privilege management systems (for example DNA, molecular fingerprints). One application could be a biometric tag containing personal information. The biometric tag could be used as a code key allowing device-independent activities. An important question is, however, the safety of the biometric information and prevention of malpractices. Biometric tags would contain information about unique personal biological properties that could be used in ways that are not intended.

Table 27. Emerging security applications – group 1. The number in brackets represents the weighted value of the discussion topic.

Security / Group 1
Confidentiality in general
• ***Identity management***
• ***Dynamic privilege management***
• ***Integrity***
• ***Long-term preservation***
• ***Non-reproducing technologies***
Security in environments and networks
• ***Automatic control in open spaces***: e.g. figure identification for cameras
• ***Invisible information security***: ad hoc, availability, PMAC + PMF, mobility...
Biometrics
• ***Biometric tags***
• ***Security of biometric information***: prevention of malpractices **(2)**

Group 2. The applications in information security can be categorized as confidentiality in general, security in environments and networks, and biometrics (Table 28). In the discussion, the confidentiality issue centred on the IPR issues, particularly on the industrial information processes. Different kinds of agent and interface applications were discussed. One suggestion in the workshop was about constructing animated agents that could endorse the trust of the users.

There were also ideas about a virus-free "Internet". This "Internet" will probably not be the same global network it is today. Instead, it will be a network built on secure modules where you should prove your identity. There will also be more open areas in the net, but their security is not guaranteed. The second category is security in environments and networks. This is an application emphasising distributed networks, where valuable information directed to a different network is assessed as non-valuable. The third category in information security is biometric identity systems.

Table 28. Emerging security applications – group 2. The number in brackets represents the weighted value of the discussion topic.

Security / Group 2
Confidentiality in general
• **IPR in the industrial information processes**: rights to use, billing, software licences like in entertainment (2)
• **Animated agents that endorse the trust of the users**
• **Virus-free "Internet"** (4)
Security in environments and networks
• **Distributed networks**: important information is directed to a different network
Biometrics
• **Bioidentifiers**: reliable electronic system, bioidentity **(7)**

5.3 Generic technologies

In the second phase of the emerging technologies workshop the experts identified the most important generic technologies in the ten year frame. The formal process was the same as in the identification of applications. The emphasis was laid on the generic ICTs and ICT concepts cross-cutting different branches. In the workshop discussions of **group 1** the central technologies can be categorized into four themes (Table 29). The first is *evolving network concepts*. This theme emphasised solutions that steer towards heterogeneous and ad hoc networking. The second category is *network technologies*. The most important solutions were wireless applications, new terminals and gadgets. Pivotal applications are the networks based on semantics. The third category highlighted in the discussions was *new media solutions*. Cross-media via multiple channels and interoperability of devices was especially emphasised.

Also, new kinds of hybrid media applications, such as intelligent paper, were seen as important future solutions. The fourth category discussed was *new technological solutions* and interfaces in the form of 3D avatars and wearable computing.

The workshop discussions in **group 2** had somewhat different emphases (Table 29). The first category was *mobility,* where new kinds of terminals and devices are emerging, 3G, wireless wideband and, in the more short-term future, the permeating of positioning technologies. The second category was *intelligent systems*. In this category the most important generic ICTs were sensor technologies, RFIDs and systems measuring the reliability of information. New kinds of distributed and flexible architectures were also important. The third category was *new interfaces*. In this category the weight was laid on the flat and flexible screens and 3D systems. Besides, systems that would empower social interaction seemed to be important. Voice-controlled systems were also seen as key emerging technologies in this sense.

Table 29. Developing generic ICTs.

Group 1 – generic technologies	Group 2 – generic technologies
Evolving network concepts • Personal Area Network • Ad Hoc networks • Ambient Intelligence: urban environment as an experimental environment, security, entertainment, informing **Network technologies** • Wireless applications: last mile, terminals, gadgets • Semantic networks: distribution of contents **New media solutions** • Cross-media: multiple channels, interoperability • Printed codes: intelligent paper, matrix codes **New technological solutions** • 3D avatars • Wearable computing	**Mobility** • Systems • Terminals • Services • WIFI • 3G • Network technologies • Wireless wideband • Positioning technologies **Intelligent systems** • Sensor technologies and networks • RFID • Systems that measure the reliability and value of information • Flexible, distributed architectures • Visualisation techniques of information semantics • Semantic web • Multi-technical modelling design **Interfaces** • Flat • Flexible • 3D • Systems that endorse communality and social interactions • User modelling in real time • Voice-controlled systems > producing, understanding and interpretation

The discussion can be further characterised via the Nordic ICT Foresight emphases. Connected to the field of communication were discussions on the generic nature of agent-based solutions. The discussion was two-faceted: on the one hand, agent-based technologies could be highly utilisable in expert services and other production enhancing applications. On the other hand, agents allow the construction of superviruses that could be a real problem for the networks of the future. Other discussed technological advances were 3D screens and holographic keyboards. It was estimated, however, that it would take at least 10 years before a 3D screen could be a commercial innovation. An interesting topic was the discussion on tailored mobile phones for different trades. The general line of discussion was that mobile communication solutions could have high variance according to the needs of the users. This could bring crucial business opportunities, as is aptly stated in Anderson's (2004) discussion of the "long tail". Furthermore, mobile devices need not resemble traditional phones. For example, people working in the field of security could find mobile phones imitating spectacles quite useful.

Generally, it was estimated that interfaces will become more important than the mere infrastructure. That is because the information infrastructure has become the most important pipeline of society: wideband mobile access could be available almost anywhere. There are, nonetheless, limits to the variations, at least in the short term. There were comments that, e.g., glasses would not be very successful general interfaces, except for certain special trades, because it was estimated that people are not too eager to use interfaces that have to be worn. It was estimated that "low tech" applications might therefore be important solutions of the future.

6. External socio-technical scenarios

6.1 Scenario building

The Nordic ICT Foresight study utilised the so-called Shell/GBN[3] method for the construction of external scenarios. In this methodology a scenario is thought of as being a picture of the future external world for an organisation (or a "system"). This means that the set of scenarios primarily deals with factors not under control by the organisation. The idea is then to discuss issues under the control of the organisation with the different scenarios as different scenes of possible future environments. Of course, in a globalised and highly connected world it is hard to judge what factors are controlled by which actor; some of the factors in the scenarios presented below could possibly be influenced by the actors in the organisation.

In many cases scenario projects are carried out in a business environment, where the decision making for a single company is in focus. In this study the organisation, or the system, is rather ill-defined. Perhaps the best definition that can be given is that the system is made up of all actors that influence the prospects of attaining the full potential of applications of ICT in the Nordic region with the aim to "increase the welfare in the Nordic countries". The focus is on *drivers* for the future socio-technical environment that may act as substantial barriers or carriers for the adoption of selected ICT solutions.

When constructing scenarios according to the Shell/GBN school there are a number of criteria they have to fulfil. Each scenario should be:

- Plausible – a scenario must not be perceived as too far-fetched.
- Relevant – a scenario must be constructed in such a way that it will address the relevant issues concerning the topic in question.
- Challenging – the scenario to add value to the strategic process, it should challenge, if not all, at least some of the collective conceptions of the future.

[3] For a general introduction see van der Heijden (1996). On the construction of scenarios in general, see for example Dreborg (2004), Eriksson (2004) and Ringland (2002).

In addition to these requirements, the whole scenario set should span the uncertainty space of the problem of interest. Even though different participants may pick their "favourite scenario", no assessment of the probability of each of the scenarios is made. It will it suffice that each of the scenarios are plausible and each scenario shall depict a probable future.

It is important to point out that the scenarios are not the end product of a scenario process. The scenarios are constructed for the purpose of being used in the subsequent steps of the process. In this project the scenarios will be input to the roadmapping and action workshops.

6.2 The scenario workshop

A further key characteristic of the methodological approach adopted here is that the set of scenarios is developed in an interactive process. This process involves individuals from a number of different organisations that are relevant for the question under scrutiny.

The kick-off to this scenario process was a workshop at Aronsborg near Stockholm in February 2006. The workshop included 19 participants representing different organisations from the Nordic countries (see Appendix A). The theme of the workshop was to outline a draft set of external scenarios for the socio-technical environment around ICT in the Nordic region. The time horizon for the scenarios was 10 years; they should describe different possible futures in the year 2016 (Figure 9).

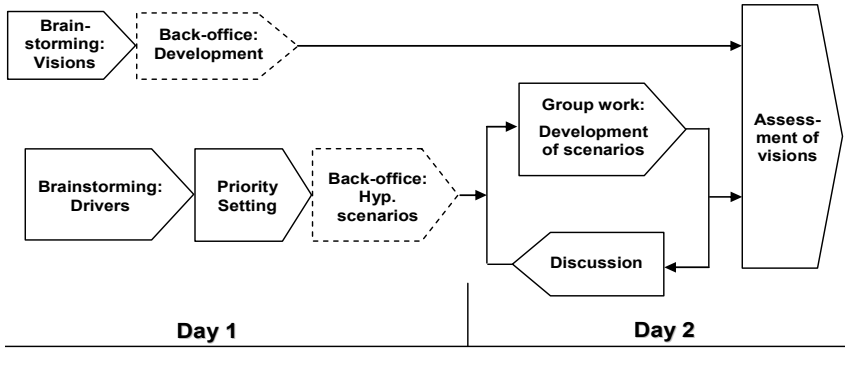


Figure 9. Scenario workshop – working process.

In short, the working process was the following[4] (Figure 9):

1. **Brainstorming of visions**. The first brainstorming session aimed at a broad collection of the participants' ideas on ICTs for the Nordic region. In Appendix B the results are sorted according to the four focus areas of the project.
2. **Brainstorming on drivers**. A broad collection of drivers without criticism and judgement on their importance. After this session in plenum, the drivers were grouped into clusters. The original list is presented in Appendix C.
3. **Priority setting for drivers**. The participants were asked to prioritise according to importance and uncertainty. The list of drivers is presented in Appendix C.
4. **Back-office development**. Based on the results of the voting, a further clustering was done. This work generated the basic dimensions of the scenarios.
5. **"Fleshing out" the scenarios in groupwork**. Based on the priorities of the drivers and the result of the back-office work, smaller groups developed the first grounds for four different scenarios.
6. **Discussion in plenum**. The result of the groupwork. Four draft scenarios were discussed and iterated in plenum.

6.3 The set of external scenarios

The four scenarios were constructed on the basis of the four quadrants of the scenario dimensions (Figure 10). The dimensions spanning the space were *User acceptance*, with end-points "harmony" and "conflict", and *Business paradigm*, with end-points "open source" and "lock-in".

[4] For details on the results of all the stages in the workshop, see Carlsen (2006) and "Minutes from Workshop on Visions and Scenarios, 9–10 February 2006" (http://nordic-ictfore.vtt.fi).

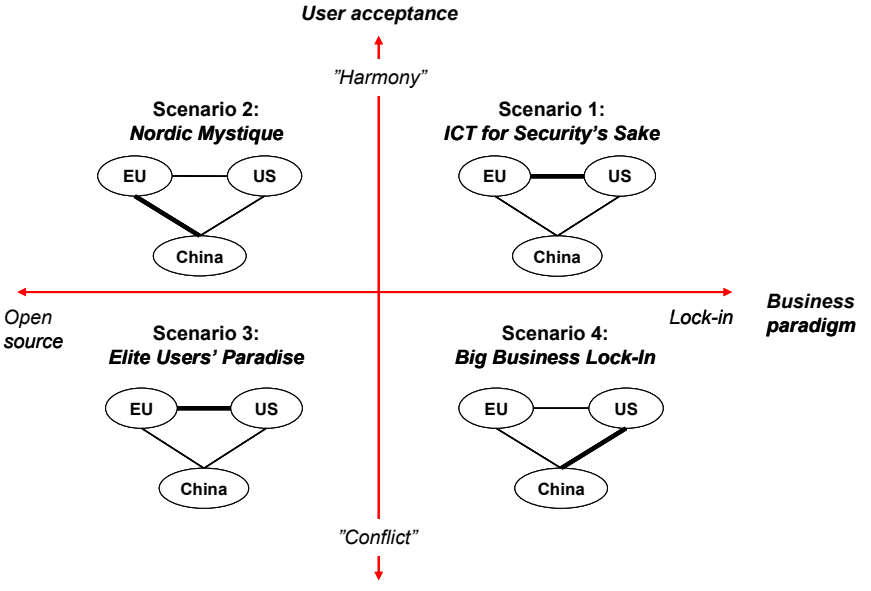


Figure 10. The Nordic ICT Foresight scenario dimensions and geopolitical emphases of the scenarios.

The scenario storylines are presented in the following section and condensed summary narratives are presented in Table 30.

6.4 Scenario storylines

6.4.1 Scenario I: ICT for Security's Sake

The 9/11 attack became the start of the Great War on Terrorism (GWOT), where the EU and US stand side by side. Partly because of demand for energy (oil), China has created strong links with Saudi Arabia, which is ruled by radical Islamic groups. As a result of global conflicts – and of the fact that China has withdrawn its investments in US bonds – there is a weak economic development.

The global situation leaves no options for the Nordic countries: the region is tightly interconnected with the EU/US alliance. Russia is both a strategic partner to the West in the GWOT and an important energy supplier. The Nordic countries try to capitalise on theses links with different strategies.

The confusion, isolation and political debate that characterised the beginning of this era lead to demand for countermeasures and security activities. The developments in the ICT sector, and the policy measures, are heavily focused on security issues. The EU is

imitating the US in many fields of policy. Homogenised solutions are developed for ICTs. Among other things, this results in strong alliances between centralised political power (especially in the US) and companies, the keys to security. The market accepts monopoly as a price for (perceived) security. In this world there is no time for long-lasting negotiations due to the fact that solutions and products are needed immediately.

As a consequence, very few big well-known companies provide the products and services, both in the business-to-business sector and in the consumer market. Big brands are symbols of security, and security comes first. MS takes a dominant role in the whole ICT world. Many companies in the telecom sector are under pressure because the desire for a single secure software platform induces MS dominance in this sector as well.

In order to cope with the terrorist threat, ICT applications for surveillance have been widely accepted by the population in the EU and the US. Personal integrity has been pushed into the background by the authorities' need to detect and track terrorists. One reaction to this development has been the construction of a physically isolated ICT infrastructure for certain applications.

Many users are discouraged from utilising anything but secure ICT services because of the repeated attacks on the infrastructure. And many users find the balance between loss of integrity and the added value from digital services unfavourable. In the Nordic countries there are attempts to try to create safe Internet platforms – initiatives with limited success mainly due to problems with interoperability.

6.4.2 Scenario II: Nordic Mystique

In this future scenario a stronger EU takes a more active role on the global scene. China and the EU are partners in many strategic issues, e.g. the economy and environmental solutions. Generally, there is a substantial influence of Asian culture and thinking in Europe. The Nordic societal philosophy – "balance in life" – has been successfully spread throughout Europe, and there are even signs of interest in certain regions of Asia.

In this world the business climate has a new important component: successful business models capitalising on products developed in the open source communities. In terms of performance and reliance, open source products proved to be more competitive than the peers, but it was the invention of new business models that really got the show going. During the period between 2008 and 2012, people really started to understand how to organise a commercial framework around open source products. This was a development that mainly took place outside the existing business actors, in the many newly formed SMEs.

One of the centres of gravity in this new business climate is the Nordic region. The Nordic way of organising society proved to be particularly well suited to the new way of developing technology and running business. The open-mind atmosphere, informal structure, and lack of heavy bureaucracy created the necessary climate for swift application-centred development.

The new development firms both complement and compete with the established companies. With varying success, the big companies also adopted the new development models. However, for the time being, new firms have taken a substantial part of the ICT revenue, hence posing a serious threat to the big firms.

Because of the dynamic climate around the new ICT companies, the Nordic countries form an attractive innovation region. The Nordic countries have very strong links with many of the dynamic regions in Asia. Many Nordic companies have succeeded in responding to the demand for products and solutions for societal and environmental problems, particularly in China. In the opposite direction, many of the Asian ICT companies are quick movers in the new open source movement and they invest in R&D in the Nordic region.

The strong focus on user-friendly services creates an atmosphere of technomania; there is a very positive attitude towards the possibilities of new technologies. Issues around personal integrity are at top of the agenda and this also helps in creating confidence in the ICT applications.

6.4.3 Scenario III: Elite User's Paradise

Around 2010, the demand for oil peaked, which resulted in the start of a rather long period of slow economic growth. Since then, the US and the EU have been on the same track regarding the energy and environmental questions. The heavy investments in technology perceived as necessary for handling the energy shortage and climate change have resulted in a slow down of economic development. The opinions among people in the West are fragmented. One group argues for tougher methods against other nations in order to secure the flow of energy to the West, others argue for the need of a more sustainable society.

The Nordic countries have a rather strong position in the EU. The Nordic region plays an important role as a transatlantic link, mainly due to the American interest in Nordic solutions – technologies and policies – regarding the environment and energy.

Regarding the use of digital services, inhabitants of the West can roughly be divided into three groups. First there is the group of elite users. This group takes full advantage of the rapid developments in the open source community. Via an interactive dialogue between users and developers – in many cases identical individuals when talking about elite users – highly customised and well functioning softwares are available to people who accept tools that are not too user friendly. The matters of integrity are polarised between the elite users and the other groups. Lack of integrity is a price other groups have to pay for the use of digital services. In contrast to ten years ago, the group of elite users is no longer a small minority. In some regions, for example in the Nordic countries, parts of North America and South Korea, this group can reach up to 15 per cent of the population.

Due to the creative, but also anarchistic, development of open source-based products, there is a need for packaging software for people outside the elite user group. Like the

pioneering Red Hat – so successful in providing products based on Linux at the turn of the millennium – many new players (e.g. Wal Mart and IKEA) now provide products based on code from the OS world. These companies – together with transformed ICT companies from the old era, e.g. Nokia and MS – are the main suppliers of products to the second group of users, the plain users. This group, the largest of the three, gets access to user friendly software with functionality that is lagging behind the software accessible to the elite users.

There are a relatively large number of people in the West who do not take part in the digital society – this is the third group of "users". These people, the ICT outsiders, do not have access to the Internet in their homes, they do not possess digital identity cards, and they do not use the new digital services in the health sector. The size of this group varies in the Western world, but in most countries it is somewhere between 20 to 30 per cent of the population.

6.4.4 Scenario IV: Big Business Lock-In

In this future scenario the economy is dominated by strong links established between the US and China. Together, these two strong nations promote a big business-oriented policy approach. In the politically marginalised Europe, the economy is lagging behind.

The internationally-oriented Nordic countries try to reach out of the isolated Europe. Partly as compensation for the decreasing contacts with other regions, the Nordic countries turn their attention to Russia. Among other things, export of ICT solutions to the Russian health sector has proven to be a success for Nordic companies.

The ICT industry has matured into a "normal" industry characterised by oligopolistic competition and locked-in customer bases. Of course, some of the so-called New Economy features so enthusiastically debated in the late 20th century remain, e.g. the fact that consumer market-driven electronics is also used in many business applications, as are standards like IP, Windows and Excel. But for more complex ICT solutions in areas like entertainment, health, manufacturing and transport there typically exists a handful of different proprietary standards and "paradigmatic" products. To convert from one standard to another is typically prohibitively expensive. Most standards are available worldwide, albeit often with strong regional variations.

The leading companies are usually based either in the US or in China. The Nordic players have been either merged into one of the big consortiums or have succeeded in forming alliances. In any case, their role has been marginalised and they have been pushed out from the front of business and technology.

The oligopolistic situation and the big business-oriented policies have created strong control mechanisms in basic research. A few big players can more or less dictate the agenda for public research financing. Universities often get direct financial support from companies, of course in line with the needs of the companies. The best universities, which are private, are naturally very business-oriented.

Big business typically works in cooperation with government, e.g. helping the governments to police the Internet. There is opposition to this, and to the whole "Big Business" environment in general. The prime expression of – and the platform for – this are the "undernets", a clandestine, invitation-only digital under-vegetation for criminals and terrorists, as well as peaceful open source activists. The majority of users, however, use the standardised Internet and the attached services provided by the leading companies.

Table 30. Condensed scenario narratives.

	***SCENARIO I*: ICT FOR SECURITY'S SAKE**	***SCENARIO II*: NORDIC MYSTIQUE**	***SCENARIO III*: ELITE USER'S PARADISE**	***SCENARIO IV*: BIG BUSINESS LOCK-IN**
GLOBAL POLITICAL SCENE	• Global terrorism & energy at top of global agenda • Shared values (conservative) US-EU in GWOT • Pakistan and Saudi Arabia ruled by extreme Islamists; allied with China • Suspected Chinese coalition with radical Islamic movements • Russia part of the coalition in GWOT	• A more isolated and weaker US than 10 years ago • A stronger EU takes a more active role on the global scene • Strong links between EU and China, and positive environmental and HR development China • A positive attitude towards globalisation in the EU • Russia a strategic partner to the US	• Top of the agenda: climate change & energy • Shared liberal values in US–EU • US and EU on the same track regarding energy and environment • EU/US concerns over HR and environmental rights in China and elsewhere • Russia and China close partners	• US oriented towards Asia • Terrorism mostly a concern for the US and China • Economically and politically marginalised Europe • Russia is important partner and supplier of energy to Europe
GLOBAL ECONOMIC SCENE	• Decline in economic development • Higher interest rates; falling real estate prices • Slow down in US home market • Slow down in China • The Nordic countries conform to the US/EU position	• Stable economic development • EU has a strong economy • China is still growing at a fast pace	• Small slow down in economic development • Big investments to handle the energy shortage and climate change	• Strong economies in Asia and the US • EU is lagging behind
NORDIC COUNTRIES IN THE GLOBAL SCENE	• Back to traditional conservative values in the West • Social and religious tensions both in the EU and between the West and the Muslim world • Mental closure around the West	• Nordic countries have a high profile internationally; attractive region for ST&I, mainly as a test market; institutional role model • Strong links between the Nordic countries and certain leading regions in Asia	• Nordic region has important role in the EU–US link • International interest in Nordic environment and energy policy & technology	• Nordic countries try to reach out of the isolation of Europe • The Nordic region is an important area for the collaboration between the EU and Russia
SOCIETAL DEVELOPMENT	• The Nordic countries conform to the US/EU position	• "Balance in life" is influential line of thought, especially in the Nordic countries • Less American cultural dominance; more balanced welfare influences • Cultural and social influences from Asia into the EU	• Fragmented opinions among people in the West; one group arguing for a tougher line against the rest of the world in the competition for energy, one group arguing for a more sustainable society	• Increased wealth concentration • Social tension in Europe (unemployed, immigrants) • Standardised entertainment global phenomena

Table 30. (continued)

	SCENARIO I: ICT FOR SECURITY'S SAKE	*SCENARIO II*: NORDIC MYSTIQUE	*SCENARIO III*: ELITE USER'S PARADISE	*SCENARIO IV*: BIG BUSINESS LOCK-IN
RELATIONSHIP BETWEEN BUSINESS AND POLITICS	• Strong alliances between centralised political power (POTUS) and companies	• Politicians in EU more positive towards the new OS business climate than their colleagues in the US	• A sense of cooperation between the political sphere and the business world on energy and climate change • Tension in the ICT industry; lack of consensus on issues related to innovation system and digital divide	• Strong alliances between business and politics (US + China)
BUSINESS PARADIGM	• Very few big well-known companies are providers of products and services in accordance with the needs of GWOT • Big brands are symbols of security, security comes first • The market accepts monopoly as a price for (perceived) security • MS takes a dominant role in the whole ICT world; telecom companies one step behind • US government picks a few trusted partners as critical suppliers of ICT • What's good for MS is good for US	• Successful business models attached to the open source movement • Many new companies built around open source • "Application-centred development" • Established ICT companies strive to adopt the new business paradigm; some are successful, some are not • Nordic region is a hot spot for the new business paradigm	• The suppliers to the consumer markets are divided into two groups: smaller high-end players that can provide the best SW from the OS world and big retailers that control the low-end ICT markets by packaging OS code: IKEA, Wal Mart (and Nokia and MS) mobile phones, PC, etc. • In B2B critical applications are provided by big companies • Slow down of ICT innovation • Problems with interoperability; different competing platforms • The consumer market has ceased to be an important driving force in ICT development	• Influential big business; strong oligopolistic competition • US and China agree on business climate in general terms • Different companies linked to different political environments • ICT as an "ordinary 21st century industry" • Technical lock-ins; No ICT hegemony • Leading global Chinese-US companies
TECHNOLOGICAL DRIVERS	• Everything dealing with "security" is of importance • Logically and even physically isolated ICT infrastructure	• ICT for health and care of the aged • ICT for environmental system solutions • Digital gaming	• Energy and climate have taken over the roles as the primary research area • The OS community is a key driver in many ICT areas • Interoperability and large-scale system engineering • Innovations in energy and environment are key drivers	• Gaming and entertainment services • Interoperability

Table 30. (continued)

	***SCENARIO I*: ICT FOR SECURITY'S SAKE**	***SCENARIO II*: NORDIC MYSTIQUE**	***SCENARIO III*: ELITE USER'S PARADISE**	***SCENARIO IV*: BIG BUSINESS LOCK-IN**
INNOVATION SYSTEMS AND R&D	• EU and the US invest heavily in R&D for security (not only ICT)	• The OS model and the main areas of applications induce "innovation in networks" – users are an important part of the development • Technology and business integrated in the R&D process • Needs and business models push technological developments	• The creative, and in many senses, chaotic OS community is at the centre of the innovation system • Large governmental research funds towards energy and environment in the EU and the US	• Business-oriented private universities dominate the market for education and academic research • Few big players dominate the R&D activities and set the agenda for policy and academic research
IPR AND COMPETITION POLICIES	• IPR is subordinated to security; "what's good for MS is good for US"	• Clash of IPR between the EU and the US; the EU has taken a radical position with regard to patent of SW; In the US, patent is the model	• Difficulties in getting patents for softwares • Big companies adapt to OS model but have trouble in keeping up with the development	• Patents for SW accepted; "in support of big business"
USER ACCEPTANCE	• Because ICT infrastructure is also part of the GWOT, there are repeating attacks on ICT systems that discourage many users • Security prevails over integrity • In the Nordic countries, people use the safe Internet platforms	• Optimistic attitude towards technologies; technomania • Strong focus on user-friendly applications; almost no one left out in the West • Digital divide between rich and poor countries • Digital integrity has high priority	• Three groups of users • 1. Elite users: Take full advantage of the development in the OS community. In many cases users=developer. The group can be as large as up to 15% • 2. Normal users: Low-end ICT users. Buyers of retail SW based on OS • 3. Non-users: Do not take part in the digital sphere; not online; no possession of digital ID	• Majority of people use standardised Internet and the services attached • Opposition to big business/big brother climate via number of "undernets", which take on many different forms and include e.g. criminals, political activists and OS enthusiasts

6.5 ICT application visions reflected against the scenario set

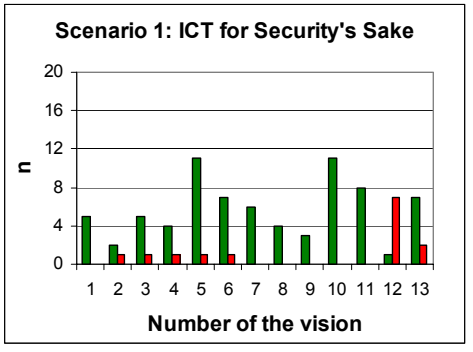
The application visions collected during the first brainstorming (see Appendix C) were clustered and further developed as back-office work between the first and second day of the workshop. The elaborated visions were then grouped according to the four Nordic ICT Foresight themes and one general theme (experience economy, health, production economy, security & ICT in general). Furthermore, the visions were given few short characterisations. The visions and the characterisations are presented in Table 31.

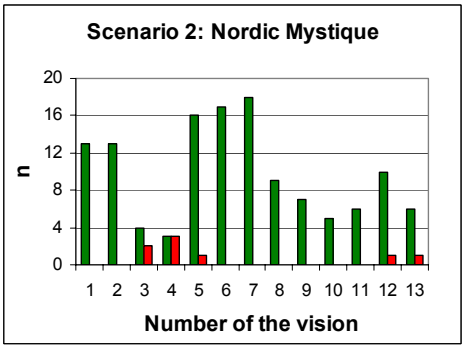
Table 31. Characterisations of the elaborated ICT visions for the Nordic region.

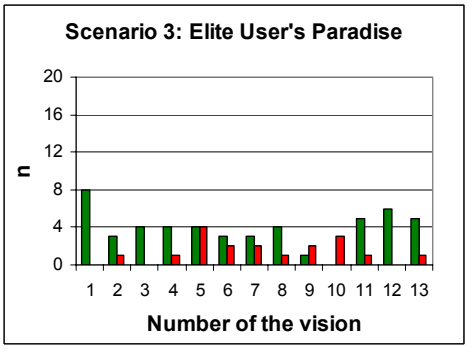
Experience economy
1. Smart training • Home exercise equipment • Virtual interface gives motivation via games • Virtual runner, runs in the landscape
2. Intelligent paper • Successful co-operation between ICT companies and the paper industry • Instant transfer of data (text, images, sound, video) from PC or mobile phone to paper • Constantly updated newspaper
3. Enhanced reality games • Add virtual elements to a real physical environment • Mixed virtual/real world • WWII with all the equipment and a whole battalion of soldiers • Fight with a lion in the Coliseum
4. All-sensor sports events • A lot of sensors are placed at various strategic positions in sports events, e.g. football (the ball, the shoes, around the arena), Formula 1, hockey (cameras on the walls, the helmets, the goal) • Create innovative online games based on sensor information; betting markets • Create new visual services
Health
5. The personal health card • Everybody has a smartcard in their wallet with all medical data • When in need of health care, individuals show their card in hospitals or in other health agencies • Activated via biometric identification • Valid in throughout the whole Nordic region • The card is only available to health institutions accredited by the State, not for insurance companies or other companies
6. Early warning system for elderly at home • Wearables with sensors attached to an individual • If e.g. blood pressure is to low, a signal is sent to the hospital • Applicable at home and directly outside the home • Also other diseases can be measured, e.g. eye movement for the recognition of dementia and Alzheimer's disease
7. Nordic common market for ICT in the health sector • There are common standards for ICT systems in the Nordic health sector • A single market of critical size for being commercially interesting • Dynamic competition between companies • One system for electronic health records and electronic health card

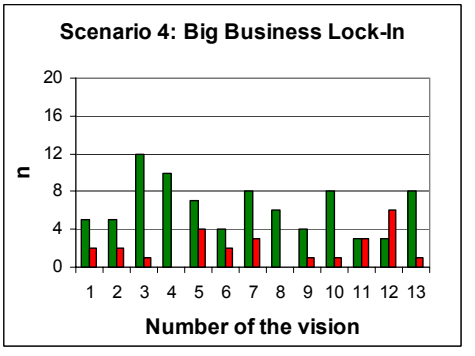
Production economy
8. Self-monitoring and robust production lines • Modularity; if the system detects a fault it warns the operator before breaking down and also reroutes the production line • Fault-tolerant production with mobile interface
9. Control system for efficient energy use • Control system for, e.g., efficient heating of buildings • Combination of sensors and optimisation algorithms radically reduces the energy need
Security
10. Closed and safe Internet • Only accredited modules are allowed to attach • Applications typically in health sector, e-banking, contacts with authorities
11. Security system for local neighbourhoods • Result of convergence between security services industry and ICT industry • Intelligent system for surveillance in local area • Alternative to gated communities • Sound balance between integrity and security
ICT in general
12. Dual online-offline spontaneous networks • Trustworthy system that permits people to be online everywhere, to log in and log out instantaneously • It is ensured that when you log out, you can't be traced or eavesdropped • When you're in, you're part of the global system
13. Intelligent distributed data storage • To be utilised in the ad hoc, device-independent mobile networks; accessible everywhere • Trustable e-Identity (via bioinformatics) is a key element in the system. • System makes a profile of the user and semi-automatically recognises the data that should be recorded, and records it in a safe storage space • The data could be files or spontaneous notes made by the user via speech recognition • Makes continuous separations between important data in the user profile, not-so-important data and threats/viruses

The participants were then asked to vote on how well these application visions support the general vision of the project, i.e. "…to increase the welfare in the Nordic countries and also in other parts of the world" in each of the four scenarios (green votes). If a vision is counterproductive for this aim in a scenario under question, red votes were given. The results of the voting are presented in Figure 11.









1. Smart training
2. Intelligent paper
3. Enhanced reality games
4. All-sensor sports events
5. The personal health card
6. Early warning system for elderly at home
7. A common Nordic market for ICT in the health sector
8. Self-monitoring and robust production lines
9. Control system for efficient energy use
10. Closed and safe Internet
11. Security system for local neighbourhoods
12. Dual online-offline spontaneous networks
13. Intelligent distributed data storage

Figure 11. Prioritisation of the application visions in the four scenarios.

As can be seen from Figure 11, the prioritisation of the visions reflected the narrative of the scenario. In scenario 1, *ICT for Security's Sake*, visions of the personal health card (5), closed and safe Internet (10) and security system for local neighbourhoods (11) got the most green votes. Also intelligent distributed data storage (13), early warning system for the elderly home care (6) and common Nordic market for health ICT (7) got green votes. In scenario 1, the spontaneous ad-hoc networking (12) was seen as quite implausible.

In scenario 2, *Nordic Mystique*, all the application visions got high green rankings. This reflected the open source and Nordic welfare spirit of the scenario. According to the votes, the scenario seemed to particularly favour the

health applications of ICT. The common Nordic health applications market (7), early warning system for the elderly at home (6) and the personal health card (5) were voted high. Also smart training (1) and intelligent paper (2) got a high number of green votes.

In scenario 3, *Elite User's Paradise*, the general number of votes was quite low. Since scenario 3 depicted a polarised user group world, the low number of votes could be interpreted as uncertainty towards the "application consequences" of the scenario. Many of the 13 application visions produced had the welfare society tone to them, meaning that, in order to be realised, most of the visions would require a quite balanced societal development and a critical mass of at least Nordic level. Smart training (1) and dual online-offline spontaneous networks (12) got the most green votes in scenario 3. The personal health card (5) and closed and safe Internet (10) got the most red votes.

In scenario 4, *Big Business Lock-In*, the green and red votes were divided most uniformly in the Nordic ICT Foresight scenario set. The scenario described a kind of business-as-usual situation, where big players dominate the developments in ICT. This scenario seemed to favour ICT applications for entertainment and leisure. Enhanced reality games (3) and all-sensor sports events (4) got the most green votes. Also common Nordic health market (7), closed and safe Internet (10) and intelligent distributed data storage (13) got quite high green votes. Spontaneous networks (12), personal health card (5), common Nordic market for health applications (7) and security system for local neighbourhoods got the most red votes.

7. Visionary roadmaps

7.1 Roadmapping in Nordic ICT Foresight

This chapter presents the results of the roadmapping workshop held in May 2006 at Hanasaari, Espoo (see Appendix A and Appendix D). The roadmapping workshop process was linked to the earlier phases of the Nordic ICT Foresight project. An especially important phase was the scenario workshop. The aim of the roadmapping workshop was to create and elaborate visionary socio-technical roadmaps for the Nordic ICT Foresight project emphases (see Ahlqvist 2006b).

How can we define the meanings of the roadmap in the context of Nordic level ICT development? The depiction by former Motorola executive and expert of science and technology roadmaps Robert Galvin might shed some light on the issues. He defined a "roadmap" in the magazine *Science* as follows:

> A 'roadmap' is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field. Roadmaps communicate visions, attract resources from business and government, stimulate investigations, and monitor progress. They become the inventory of possibilities for a particular field. (Galvin 1998 cit. Kostoff & Schaller 2001, p. 132.)

What can we distill from Galvin's statement above? Roadmaps

- are an extended look at the future of a chosen field of inquiry
- are composed of the collective knowledge and imagination of the drivers of change in a particular field
- communicate visions
- stimulate investigations
- monitor progress
- are the inventory of possibilities in a particular field.

Now, knowing the basic elements of the roadmaps, we propose our special brand of visionary socio-technical roadmaps for the Nordic ICT Foresight (Figure 12). *Visionary socio-technical roadmaps* aim for the targets defined in the bullets above by (1) *emphasising application visions that are embedded in the roadmap structure* and (2) *by combining different layers of society and technology*. In this project, the roadmaps have five layers: education and science, technology, business and industry, markets and government. It is crucial to note that the roadmaps are application-oriented and visionary, i.e. they do not try to depict all the possible development trajectories relevant to the sector under scrutiny. Instead, the roadmaps produce partial glimpses of the elements and development paths surrounding a certain application. The applications roadmapped in this exercise can be labelled either *visions of development trajectories in the systemic level* (e.g. roadmaps of the intelligent systems in the self-care or the secure management system of the energy) or *potentially disruptive application visions* (e.g. roadmaps of the automatic language translation and personal traffic agent for security).

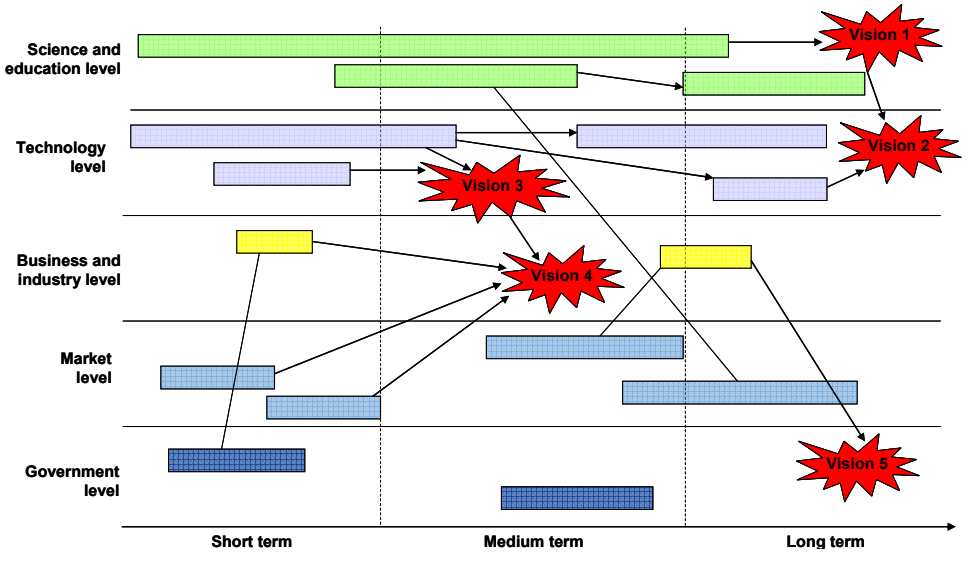


Figure 12. The ideal model of the visionary socio-technical roadmap.

The key idea in the construction of the roadmaps was to combine external scenarios and visionary development paths. Therefore, each roadmap was basically built within the context of one of the four Nordic ICT Foresight

scenarios. Roadmaps were created on the project's four themes: experience economy, health, production economy and information security. For each of the socio-technical visions – or groups of these – the workshop discusses the potential developments on the following five roadmap levels:

- science and education (needs for scientific research, needs for competences)
- technology level (networks, terminals, content delivery, quality of service, security among others)
- business/industry level (business opportunities, business development in the match between technologies and markets, finance, industrial standards)
- market level (market mechanisms and end use markets)
- government level (industry policy, public R&D, early market stimulation, standardisation).

The connections between the scenario and roadmapping workshops were made by linking each thematic roadmap to a certain scenario. In this way the process produced scenario-based roadmaps on the four Nordic ICT Foresight themes. In the simplified form, the combination of a theme and a scenario was decided in advance in the core group of Nordic ICT Foresight. In the actual workshop, the scenarios were thoroughly described by emphasising three or four main characteristics of the scenarios. By advancing in this manner, the following combinations of themes and scenarios were formed: Experience economy – Big Business Lock-In, Health – The Nordic Mystique, Production Economy – Elite User's Paradise and Security – ICT for Security's Sake (Figure 13).

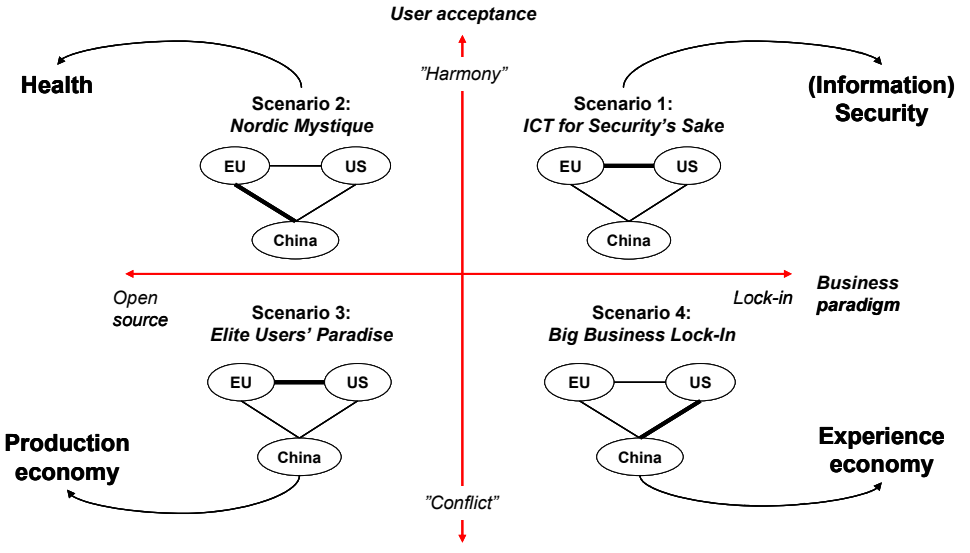


Figure 13. Linking scenarios and roadmaps.

The actual roadmapping process is clarified in Figure 14. The key starting point of the roadmapping process was quite general. In short, it can be presented as the following: to produce socio-technical visions that enhance Nordic productivity, and create jobs and well-being. The roadmapping workshop process was structured in three plenary sessions and three groupwork sessions.

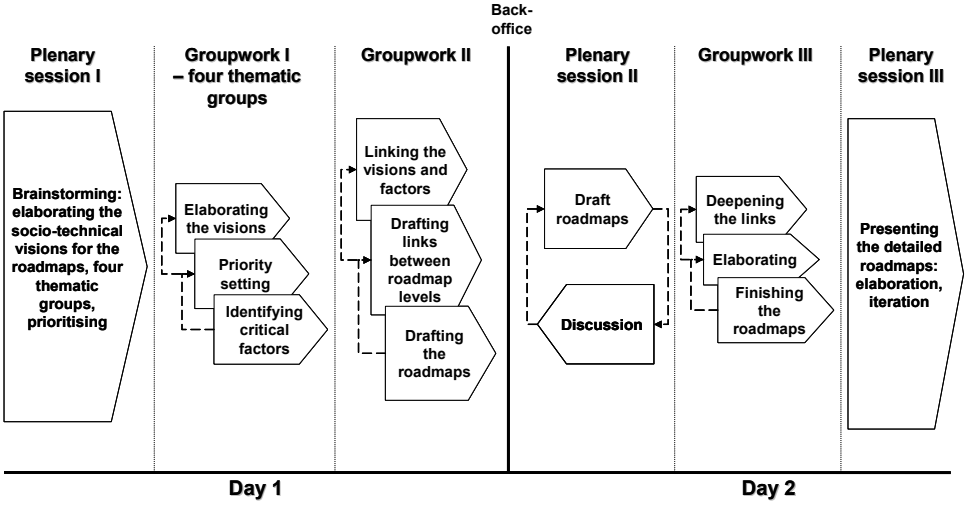


Figure 14. The structure of the roadmapping workshop.

The first plenary was brainstorming, where the specific socio-technical visions for the roadmaps were gathered and prioritised. Groupwork I was about elaboration of the prioritised visions. The second phase in groupwork I was to identify critical factors on the roadmap levels. The key question was: What are the enabling and constraining dimensions of each factor? In groupwork II the groups elaborated the critical factors on the roadmap levels, characterised and explicated the links between the factors, and drafted the roadmaps in linear sequences. The method was based on vision stars that were formulated on the basis of the roadmap layers (Figure 15).

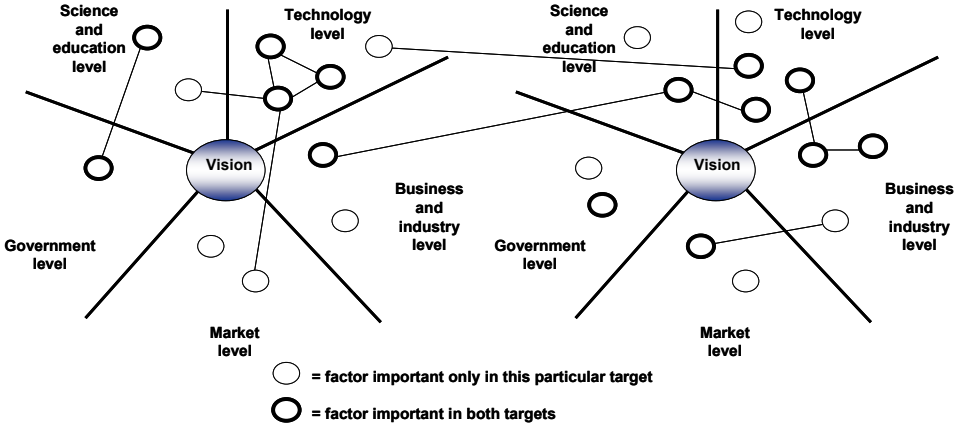


Figure 15. Linking visions in the workshop.

In plenary session II at the start of the second day a draft roadmap of the experience economy was presented for stimulation of the groupwork. In the following groupwork III the non-linear elements of the roadmaps were characterised and detailed, the links between the roadmap elements were deepened, the roadmap targets were linked to different levels (science, technology, business/industry level, market level, government level) and the roadmaps were prepared for plenary session III. In plenary session III the outcomes of the workshop were presented and discussed.

7.2 Visionary roadmaps in Nordic ICT Foresight themes

7.2.1 Nordic ICT Foresight roadmap summaries

The key idea of the roadmapping process was to produce roadmaps within the context of the four Nordic ICT Foresight scenarios. Therefore, some of the elements in the roadmaps should be understood as consequences of this research decision. However, it should be emphasised that although the scenarios formed the basic context for the roadmaps, the roadmaps are meant to be read in a general sense as well. The roadmaps include elements and paths that are valid for the Nordic level despite the external developments that may or may not be realised in the future. Therefore, the scenario context of the roadmaps should not be read as a too rigid or too deterministic framework. Hence, in the roadmap narratives the scenario context is deliberately faded from the front, but it should be seen as a background and a source for the described developments.

Tables 32, 33 and 34 present summaries of the roadmaps constructed on the Nordic ICT Foresight themes and scenarios. Table 32 presents the general Nordic level summary of roadmaps and emerging technology evaluations. On the basis of the roadmaps, the following synthetic conclusions can be made. In the *short term* (1–5 years) there is an overall trend towards convergence of ICT solutions and formation of modular solutions. ICT technologies and products are still quite disparate and without common frames. Separate technologies are applied to different platforms e.g. mobile, entertainment and production. The key question is that solutions in the short term are tailored to different user contexts. However, there are considerable increases in the number of relationships between different ICTs. In addition, central technological platforms are being designed and constructed. In the *medium term* (5–10 years) there is an overall trend towards the actualisation of a mobile network society. This means that technological readiness for the realisation of the new level of network society will be somewhat reached. Technological readiness is based on compatible and multi-channelled devices and context-aware applications. There are developments towards the formation of heterogeneous networks. These new multi-channelled devices enable personally tailored communication and media services, e.g. ubi-services which utilise intelligent agents and distributed data storage in real time. There are waves of convergence within the ICT application groups. ICTs are becoming more embedded in materials and objects. This

development intensifies the depths and dimensions of networking. Also, new technological solutions are about to emerge, such as 3D and flexible screens and fuel cell batteries. In the *long term* (over 10 years) the mobile network society more or less exists, which means that the everyday environment is "stuffed" with sensors and communication terminals that are constantly forming ad hoc links. ICT devices network spontaneously with other devices, platforms and everyday objects. This creates possibilities for different services, but also forms specific information threats. Overall, it is crucial to acknowledge that the social and ethical dimensions of the technologies should be important levels of societal discussion in the short and, especially, in the long term – networking technologies enable transparent utopian development trajectories as well as dark dystopian ones.

Table 32. General Nordic level summary of roadmaps and emerging technology evaluations.

SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
• Converging ICT solutions • Formation of modular ICT • Disparate groups of ICT technologies and products: technologies are without a common frame • Separate applications are utilised in different technological platforms: e.g. mobile, non-mobile, entertainment, work, production, and housing • Increase of relationships between different ICTs • Central technological platforms are being constructed	• Towards a mobile network society • Personally tailored communication and media services: ubi-services, intelligent agents, distributed data storage and information search... • Compatible, multi-channelled devices: convergence, forming heterogeneous networks, ad hoc, context awareness… • New technological solutions: 3D screens, flexible screens, fuel cell batteries, etc. • Embedded intelligence in materials and objects • Convergence and compatibility of ICT groups	• Existing mobile network society > ubiquitous solutions in everyday environments • Ad hoc heterogeneous networks • Spontaneously linking and communicating devices and platforms • Everyday environment is immersed in ubiquitous solutions and embedded systems • Ambient intelligence and ubiquitous computing • Sensor networks

Table 33 presents a general summary of the thematic roadmaps in the Nordic ICT Foresight. The first row summarises the roadmaps in the *experience economy*. In the *short term* (1–5 years) the technologies are based on different network technologies and solutions, e.g. peer-to-peer and parallel networks. In addition, communicating embedded solutions, such as RFID are emerging. The potential business models emphasise the utilisation of user-generated content and the creation of integrated service concepts. In the theme of experience economy there was discussion about already springing "policy products", i.e. ICT solutions that enable new government practices in cyberspace. In the *medium term* (5–10 years) combinations of product platforms are forming. Applications are becoming more modular and devices communicate through

different network platforms. There are strong development trajectories in mobile applications as well as in semantics and information ontologies. Another strong trajectory is materials and fabrics with embedded sensors, i.e. intelligent materials. In the medium term the business models are based on the concepts that emphasise user-generated content and models based on mobile and real-time integrated service concepts. Some potential disruptive elements were identified and sketched in the scenario workshop. It was acknowledged that applications based on, e.g., automatic language translation bring potential for the Nordic ICT developers. In the *long term* (over 10 years) the roadmaps anticipate fluidly and spontaneously communicating product platforms. Sensors will be embedded in infrastructure, materials and moving objects, thus enabling spontaneous ad-hoc networks. In the long term there will be new business models based on service concepts utilising networked environments and utilising semantic web and agents technologies. In addition, new and efficient battery formats and energy systems could be created for ICT terminals and devices.

The second row in Table 33 summarises the roadmap on the *health* theme. In the *short term* (1–5 years) the roadmap emphasises ICT-based support systems for health care, especially for treatment (e.g. diabetes) and measuring (e.g. blood pressure, targeting and dosing of medicines). The alarm systems and products for the aging population are also highlighted. ICT applications are focused on bioinformatics, bio-information systems and databanks, which are used as extensive biological datasets for data mining. In addition, these datasets and ICT applications for simulation and visualisation are utilised for modelling, e.g. biological interactions. In the medium term (5–10 years) the roadmap emphasises the potential of the Nordic platform for testing the customer markets of the developed health applications. The ICT applications are focused on advanced "home medicine" solutions, e.g. monitoring systems, virtual pharmacies, alarm systems, virtual and distance medicine. ICT-based diet and nutrition systems are applied and utilised. New technological advances in chip laboratories and ePrevention will grow in importance. There is also a growing need for socio-technical innovations that enable the utilisation of ICTs in home medicine. These include, for example, innovations in service automation and customisable interfaces using combinations of senses. In the *long term* (over 10 years) it is anticipated that the Nordic test market will develop into a Nordic health support system endorsing ICT applications for research, self-care and monitoring. The health ICTs could, in the long run, be utilised in the ubiquitous health environments that adapt to personal health conditions.

Table 33. General summary of the visionary roadmaps in the experience economy and health.

THEME	SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
EXPERIENCE ECONOMY	• Business models based on the utilisation of user-generated content • Business models based on integrated service concepts • "Policy products" > ICT solutions that enable new government practices in cyberspace • Network technologies and solutions: peer-to-peer, parallel networks • Communicating embedded solutions, e.g. RFID	• Product platforms and modular solutions > devices communicate through different networks • Business models based on the utilisation of user-generated content • Business models based on mobile and real-time integrated service concepts • Developments in mobile technologies, semantics and information ontologies • Intelligent materials and fabrics with embedded sensors • Automatic language translation as potentially disruptive technology > lock-in breaking possibilities for smaller language groups	• Sensors embedded in infrastructure, materials and moving objects • Fluidly and spontaneously communicating product platforms • Business models based on service concepts utilising networked environments • Semantic web • Agent technologies • New, efficient battery systems for the ICT terminals and devices
HEALTH	• Alarm systems and products for the aging population • Need for innovations combining social and technological aspects • Databases • ICT-based support systems for healthcare: e.g. diabetes, blood pressure, targeting and dosing of medicines • Bioinformatics, bio-information systems and databanks: extensive biological datasets, data mining, interactions • Simulation and visualisation: e.g. system biological interactions, protein research, virtual models	• Nordic platform to test the customer markets of the developed health applications • Applying advanced "home medicine" solutions > monitoring systems, virtual pharmacies, alarm systems, virtual- and distance medicine • Socio-technical products: service automation, customisable interfaces using combinations of senses • ICT based diet and nutrition systems • Chip laboratories • eHealth and ePrevention: data warehouses, data mining and drilling • User generated applications in healthcare?	• Adaptive ubiquitous environments > environments and buildings that adapt to personal health conditions • Nordic test market develops into Nordic health support system endorsing ICT applications for research, self-care and monitoring • Nano- and picosensors

The summary of the *production economy* roadmap is presented in the first row of Table 34. In the *short term* (1–5 years) ICT applications in the production economy emphasise ICT-based distributed local energy solutions, mass-tailored production lines and on-demand systems. It is anticipated that knowledge management principles will permeate all levels of the production economy and bring lifecycle management, performance indicators, simulation and design tools to the core of industrial processes. Advanced control systems will be important for the ICT applications. Modularity, flexible architectures, advanced algorithms and unexpected situation management are expected to rise in the short term. Applications that are based on mobility will be accentuated in the form of mobile interfaces and mobile maintenance systems. In the short term the sensor applications, especially RFID, and field devices, e.g. sensor fusion and sensor actuator smart devices will be emphasised. In the *medium term* (5–10 years) the ICT applications will be integrated to form fluid and mobile data transfer. In the medium term the lifecycle management systems will be converging, and real-time analyses of the production process and logistic data will be highlighted as well as new industrial applications stressing, e.g., automatic reasoning, error seeking and systemic optimisation. New analysis systems and user interfaces will also emerge. These include for example mobile terminals, fault navigation tools, abnormal situation management tools and different visualisation applications. In the *long term* (over 10 years) the roadmap emphasises the control systems for efficient energy use on the Nordic level. In the industrial sphere the developments will emphasise intelligent and adapting devices for the production systems. These will be based on the applications of agent technologies. The emerging fully automatic factories will be maintained and repaired by mobile and automatic maintenance systems.

The second row of Table 34 presents the summary roadmap for the *security* theme. The *short term* (1–5 years) sketched in the Nordic ICT Foresight accentuates simulation and scenario models for the prognoses of crises in the societal systems, i.e. platforms, plants and infrastructures. In addition, simulation models for the implementation of sensor systems, for example in the traffic system, are needed for the efficient planning and anticipation of security issues. The networked infrastructures, e.g. energy, roads, electricity, as well as the ICT infrastructure, require new kinds of security concepts. Furthermore, concepts for "invisible" security will be needed because mobile and networked solutions should have fluent security levels. Moreover, the key questions of information

security will be strongly emphasised. These include identity management of the users, long-term and safe preservation of the data and utilisation of distributed networks to minimise the escalation of viruses and infiltrations. The questions of IPR management and software standardisation will be high on the agenda in the short term. In the *medium term* (5–10 years) the key issue raised in the workshops was biometric information security, which emphasises the preservation of biometric information in digital form gathered via biometric tags and bioidentifiers. Another key topic is the non-reproducing technologies that could be basis for the formation of robust security systems. All in all, security on the level of links and networks will be crucial. This means the creation of new information security protocols, ways to secure information flows and guaranteed authentication algorithms. The issue of network trust will be highlighted. Network trust covers the prevention of eavesdropping and scanning of private information, obstruction of unauthorised access, preparing checks for the "man-in-the-middle", blocking of "backdoors" and the entrance of Trojan horses and, on the whole, preventing the system malfunctions and breakdown caused by potential viral attacks. Considering these issues, it is anticipated the infrastructure and network security applications will be an important development trajectory in the medium term. In the *long term* (over 10 years) there should be large-scale security concepts for the ad hoc network solutions and general communication infrastructure. Moreover, infrastructural security applications rise in importance when sensor systems are embedded in the large static infrastructures, e.g. roads, electric wires and energy pipelines.

Table 34. General summary of the visionary roadmaps in the production economy and security.

THEME	SHORT TERM: 1–5 years	MEDIUM TERM: 5–10 years	LONG TERM: over 10 years
PRODUCTION ECONOMY	• ICT-based distributed local energy solutions • Mass-tailored production lines and on-demand systems • New mobile interfaces to control the production processes • Mobile maintenance systems • Simulation and design tools • Field devices: e.g. sensor fusion, sensor actuator smart devices • Applications based on RFID • Knowledge management principles permeate all levels of the production economy: lifecycle management, performance indicators, simulation • Control systems: e.g. modularity, flexible architectures, advanced algorithms, unexpected situation management	• Testing the ICT-based energy control systems in the Nordic level • Fluid and mobile data transfer • Real time analysis of the production process and logistic data • Automatic reasoning, error seeking and optimisation systems • Convergence of life cycle management systems • New analysis systems and user interfaces: e.g. mobile terminals, fault navigation tools, abnormal situation management tools, visualisation	• Control systems for efficient energy use on the Nordic level • Intelligent and adapting devices in the production systems • Fully automatic factories • Mobile and automatic maintenance and repair • Agent technologies in the production systems
SECURITY	• Simulation and scenario models for the prognoses of crises in the systems > platforms, plants and infrastructures • Simulation models for the implementation of sensor systems, e.g. in the traffic system • Questions of standardisation • Development of network and infrastructure security concepts • Concepts for the “invisible” security > security should be as fluent and invisible as possible • Identity management • Long-term preservation • IPR management • Distributed networks	• Biometric information in digital form • Biometric tags and bioidentifiers • Non-reproducing technologies • Trustable and secure information systems: eavesdropping, scanning of private information, unauthorised access, "man-in-the-middle", system breakdown, trojan horses, backdoors... • Security on the level of links and networks: information security protocols, secure information flows, authentication, security in the mobile and heterogeneous networks • Infrastructure security applications	• Information security for ad hoc network solutions • General security and filtering solutions embedded in the communication infrastructure: DRM, SPAM, virus • Security applications in the sensor systems over the large static infrastructures, e.g. roads, electric wires and energy pipelines

7.2.2 Experience economy – Big Business Lock-In scenario

The roadmap in the experience economy was constructed in the Big Business Lock-In scenario. In a nutshell, this scenario is characterised by the dominance of big ICT players and oligopolistic competition. Big players sell standardised products to the customers. There are strong links between politics and business, especially in the case of the US and China. Smaller firms are mainly subcontractors to the bigger players. However, there is opposition ("undernets") to the dominance, which emphasises political activism and an open source development spirit. In the discussions in the roadmapping workshop this scenario was understood to be a somewhat business-as-usual scenario for the coming five to ten years. That is why the scenario framework did not produce too much difficulty in the context of the experience economy.

The expert group in the roadmapping workshop formed a number of visions that could be put under the category of the experience economy (see Appendix D). After the prioritisation, the following three visions were chosen for the construction of the roadmaps: automatic language translation, intelligent fabrics and intelligent paper, and intelligent lenses. All of these visions can be understood as disruptive visions because the technical format and timetable of their realisation is still very much open, but if these are commercially realised – especially in the Nordic context – they might prove to be disruptive in their effects. However, all of the disruptive roadmaps contain elements that could be generalised to affect the Nordic level in the wider sense. Two of the constructed roadmaps are presented here: automatic language translation (Figure 16) and intelligent fabrics and paper (Figure 17).

Roadmap of automatic language translation. In the *short term* (1–5 years) the emphasis is on basic research in the natural sciences, and humanistic and cognitive research in the structures of language and business-oriented design. The technology utilises standard software, where translation can currently be done in a controlled environment using keywords. The effect of scenario thinking is present on the business level, where it is assumed that big players are forming loose cartels to lock the prices and lock the markets by mainly producing goods with one language. In this situation the Nordic countries might have some possibilities because of the advanced techno-economic infrastructures and the fact that there might strong local markets for translations in the smaller

languages. On the market level this would naturally result in a price lock-in and the accentuation of path dependencies. However, the move towards a service economy puts the weight on direct contact between the producers and the customer, hence the meaning of language as business factor is highlighted. On the government level the scenario framework was seen to result in "policy products". Policy products are customised products of the big ICT producers that are fitted to some special political purpose. This situation is already a reality in the form of a customized Google search engine for the Chinese government. Other big players are currently making "policy customisations" for the Chinese government due to the market expectations. However, in the roadmapping workshop it was estimated that the Nordic region might have potential in this situation by actively engaging in the countertrends: lock-in-breaking policies and policies that promote interoperability and open source. In the *medium term* (5–10 years) the advanced research in semantics and ontologies are the drivers of translation. The results in these fields enable the conversion between different language structures and different alphabets. This would lead to advanced translation prototype devices that could be used as devices for learning languages. On the government level there would be a need for governmental procurements in technology in order to gather a critical mass for the research, development and commercialisation of the translation innovations. In the roadmap it is assumed that somewhere between the medium term (5–10 years) and the long term (over 10 years) there would be realistic possibilities for the realisation of automatic translation devices that could fluently translate many languages and also make conversions between written and spoken languages. The translation devices could be small and portable or it might be possible to embed the translation softwares and algorithms in general mobile technologies. This kind of development could lead to disruptions in ubiquitous solutions and user interfaces.

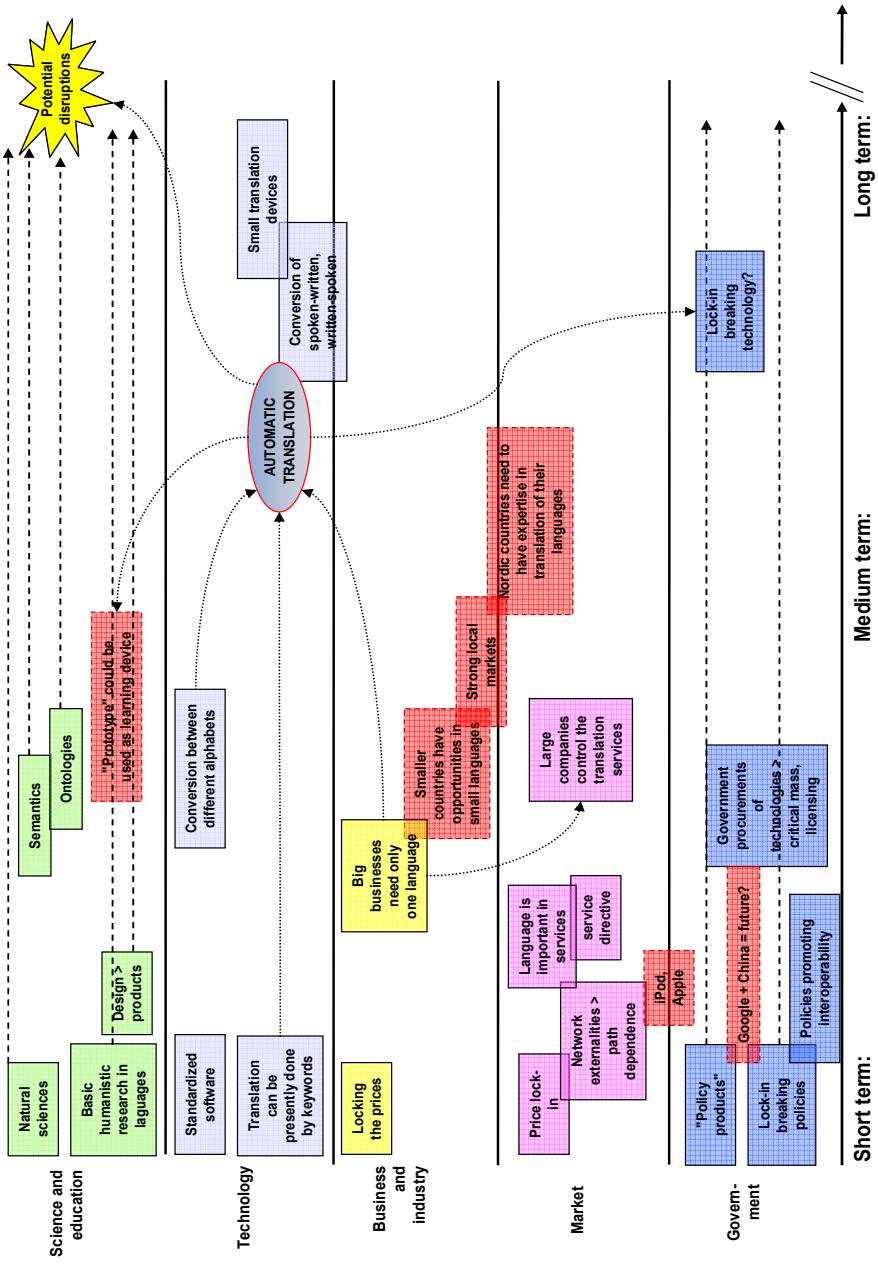


Figure 16. Experience economy roadmap 1 – Automatic language translation.

Roadmap of intelligent fabrics and intelligent paper. In the *short term* (1–5 years) there is basic research in natural sciences, nano and material technologies, and design. Standardised software platforms are utilised in the technologies. In the materials field the basic sensor technologies, e.g. RFIDs, are embedded in all kinds of materials. The combinations of fabrics and electronics will first emerge in the industries. In the consumer markets the market acceptance of the "tagged" clothes and other applications might prove to be a critical point. Large developments in the combinations of fabrics and electronics are made. On the business and market levels the situation is supposed to be the same as in the automatic language translation roadmap: the big players control the markets with standardised solutions that only give the smaller players room in the form of a subcontractor. On the government level the "policy product" emphasis is also present, as is the potential to promote open source policies on the Nordic level. In the *medium term* (5–10 years) it is assumed that the intelligent fabrics and intelligent paper applications will enter the markets. These applications might be structured and coloured, changing clothes, military gadgets and packages with all kinds of sensors, landscape walls and illuminating wallpapers. It is possible that the formation of consumer markets may take some time. However, this depends on the nature and permeability of the applications. If the basic production technologies will prove to be so cheap that most of the consumer packaging could be "sensored", a new kind of market potential for functional packaging and logistic planning will emerge. The products with intelligence might also enable some restrictive policies and monitoring practices. This situation, if the restrictions and monitoring are seen as too overarching, might result in the formation of all kinds of "undercurrents" and "undernets". In the *long term* this might create niche markets for traditional, "non-intelligent" products.

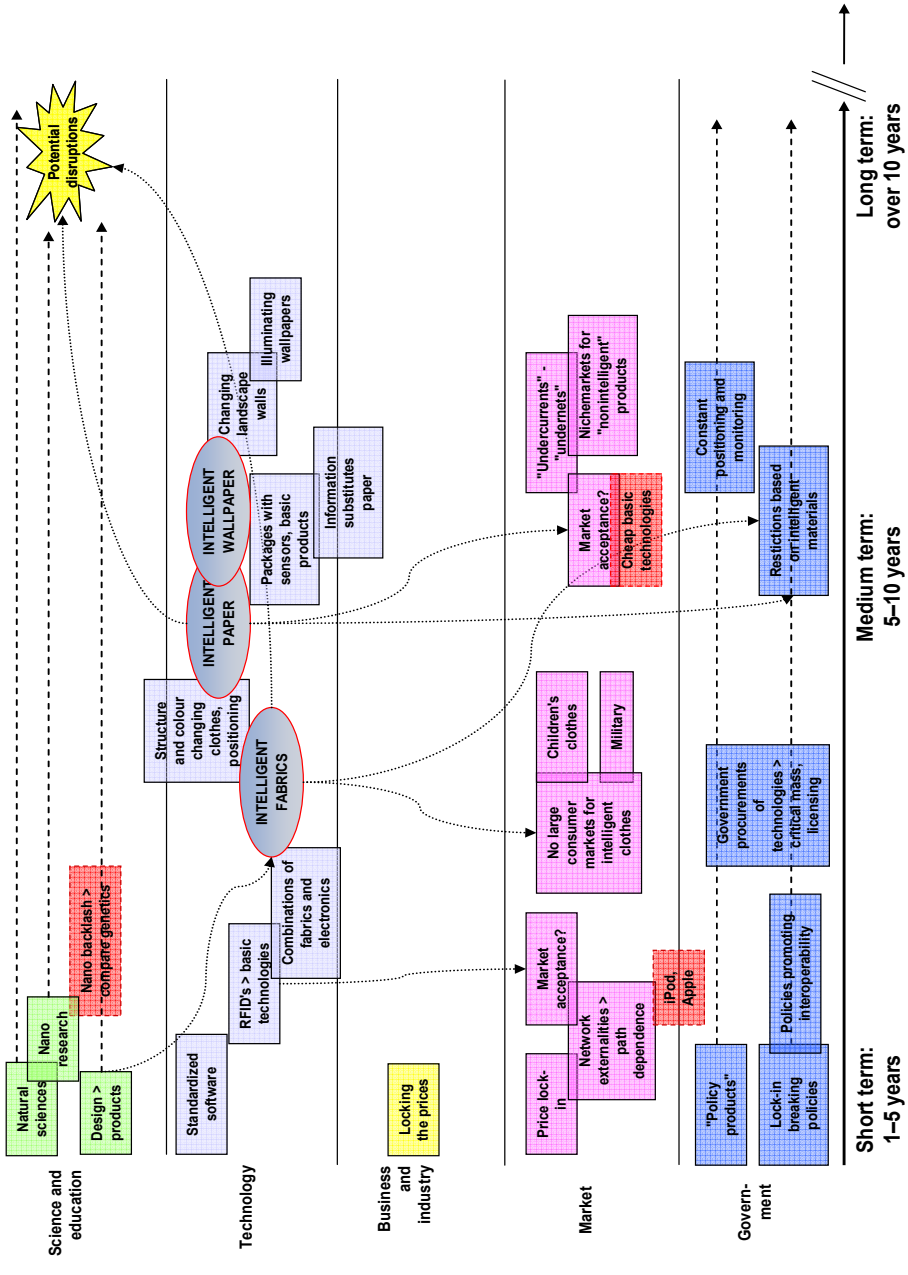


Figure 17. Experience economy roadmap 2 – Intelligent fabrics and intelligent paper.

7.2.3 Health – Nordic Mystique scenario

The health roadmap was made in the Nordic Mystique scenario. In brief, the scenario emphasises a harmonic open source development that gives a lot of room to a prosumeristic mindset (users as producers). This will give business possibilities to SMEs. There is a somewhat general consensus that the Nordic welfare-driven society is the ideal model. This will result in user-oriented applications and activities to balance the digital divide. In the Nordic ICT Foresight roadmapping and action workshops this scenario was seen as the most optimistic, and in its optimism somewhat unplausible. In this context one should be reminded that in this study the scenario thinking is approached as a strategic tool that puts the weight on the differences and similarities of the issues and developments potentially emerging within the scenario framework. Therefore, the "realism" of the scenarios is not as important as their capacity to form interesting and alternative views of the future – it is very unlikely that any of the scenarios will be realised as such. This is of course the case with most of the scenario studies.

The expert group in the roadmapping workshop formed different visions in the health context (see Appendix D). The visions were voted on and the following two visions were chosen for the basis of the roadmapping: an ICT-based self-care system and the personal health card. These visions were then elaborated and generalised into individual health information that goes with the person and intelligent systems for self-care, diagnosis and monitoring. Finally, an integrative roadmap on the intelligent systems for self-care, diagnosis and monitoring was constructed (Figure 18). If the roadmaps on the experience economy were more disruption-oriented, the roadmap on health is more systemic – it clarifies and crystallises elements and trajectories that are required in order to reach a system that enables self-care, diagnosis and monitoring.

Roadmap of intelligent systems for self-care, diagnosis and monitoring. In the *short term* (1–5 years) the science and education emphasis should be on the documentation and practices of self-care, individual well-being and preventive care. The key problem is how to change healthcare thinking into a direction that enables a more decentralised system to emerge. Technologies in the short term are based on sensors, on communication applications and on different database

technologies. Developments in decision support systems are also required. The business applications focus on alarm systems and demographically driven products for the elderly. In the short term the new products are mostly sold through existing market channels, e.g. pharmacies. Governmental initiatives in the short term emphasise the need money for the start-ups, different kinds of support for the research and development, cost-effective forms of self-care and standards setting. Important government functions would also be to stimulate pilot products and set initiatives for the selling and exporting of different kinds of health applications. In the *medium term* (5–10 years) the key scientific approaches should emphasise scientific hybrids, like combinations of cognitive, psychological and pedagogic research in e-learning. Medical practitioners should be educated in the fields of the new self-monitoring applications. In the medium term there should also be studies evaluating the impact and future of the developed system. On the technology level the combinations of technological and social innovations are of high importance. These socio-technical innovations could handle service automation, user-friendly and customisable interfaces, and technologies that use a wide variety of senses (sight, hearing, touch, smell, etc.). The key issue is to engage in a discussion on how far the technologisation of medical practices can be taken. The business level in the medium term is focused around small business development and the development of a novel Nordic platform – a kind of protomarket – to test the developed applications. In the medium term there might also be some experiences with private markets and customisation of the health products into cultures other than the Nordic one. On the governmental level the most important initiative is to make regulations that ensure the technical and social security of the system. In the *long term* (over ten years) the Nordic test platform is developed into a Nordic health support system that endorses self-care systems. In the long term, and with some successful applications, there might be dynamic global markets for all kinds of user-generated applications in healthcare.

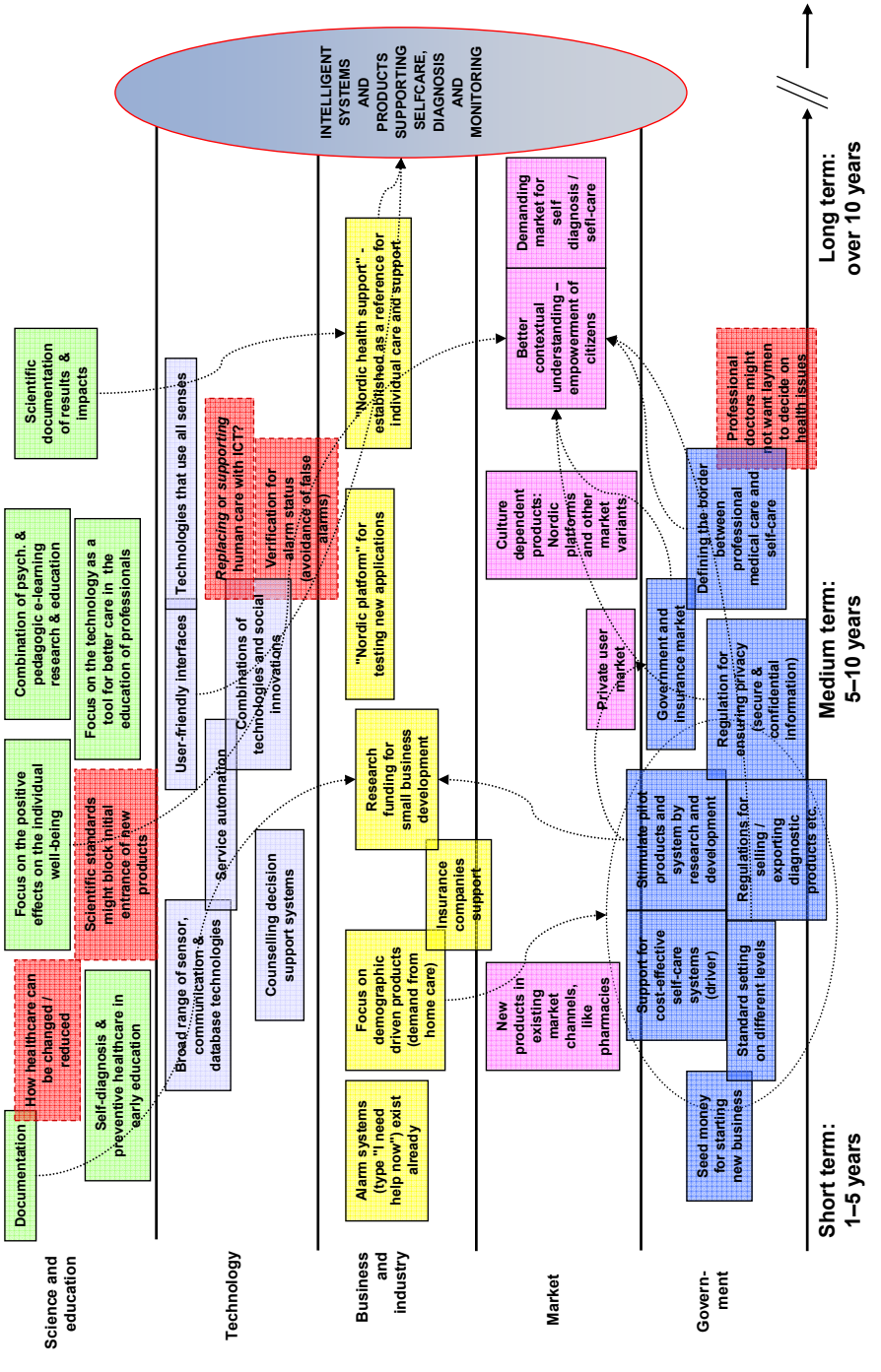


Figure 18. Health roadmap – Intelligent systems for self-care, diagnosis and monitoring.

7.2.4 Production economy – Elite User's Paradise scenario

The roadmap for the production economy was made in the Elite User's Paradise scenario. To sum up, this scenario describes the societal position where ICT users are polarised into two user groups: high-end users with customised and advanced applications and low-end users with standardised ICT products. There is also a third social group that has dropped out of the ICT environment. Energy issues are of crucial importance in this scenario. The open source community drives the elite user applications; the low-end products are made in a cost-effective style.

The expert group in the roadmapping workshop produced different visions within the framework of the production economy (see Appendix D). Three visions were chosen on the basis of the prioritisation: a control system for efficient energy use and new clean energy without disturbing the environment, a digital production / one click cleaning system, and a business system for the informal economy. Three draft roadmaps were made. One production economy roadmap is presented in this publication: a control system for environmentally sustainable and efficient energy use (Figure 19). As with the previous health theme, this roadmap is also systemic – it produces glances into the future of the energy infrastructure behind the production economy.

Roadmap of control system for environmentally sustainable and efficient energy use. In the *short term* (1–5 years) the basic research emphasises the natural sciences and the technical sciences from the viewpoint of combining energy, environment and ICT applications. Different sensor solutions, e.g. infrastructure and environmental monitoring, are also important. Some directed funds should be allocated to research in nano-technological solutions as well as simulation tools. Efficient feedback monitoring systems are important technological requirements for the construction of a large-scale energy control system. On the business level, energy is considered more a part of the business logic of different actor networks that are engaging in co-operation to build up this system. One possibility is that governments lend energy from the national reserves to the businesses in order to develop the system. However, this could lead to a paradox where companies sell the cheap energy allocated from the government resources. On the market level, the first step would be to set up

initiatives for the Nordic Energy Market similar to the kind envisioned in the health roadmap. Governments could promote this development by making tax incentives and regulations to ensure the necessary competition. Other governmental activities in the short term would be to define suitable efficiency levels, standards, prices and availability of the energy for the system. Another initiative would be to give green certificates for the promising sustainable solutions. In the *medium term* (5–10 years) there is a need for hybrid approaches that thrive to understand the ways of merging "fast ICTs" into the large and more slowly evolving energy infrastructures. Sensor technologies to measure upstream (getting energy) and downstream (the functioning of the infrastructure) are part of these hybrid approaches. The actions require different kinds of evaluation information on the combinations of such "fast-slow" infrastructures formed by ICTs and energy. On the business and industry level, networks based on complementary industrial bases are needed as well as Nordic cooperation on standard setting. In the *long term* (over ten years) there could be a control system for efficient energy use that is built on activities in the Nordic energy markets based on international management. On the government level this development would need all kinds of cooperative policies on the Nordic level, especially considering the price of energy. These policies could be focused on standards and endorsing the industry by different incentives. In the *very long term* (over 15 years) new kinds of energy alternatives could be integrated into the system, e.g. submarine power platforms, new ways to produce nuclear energy, fuel cells and energy produced from natural phenomena (solar cells, wind, tides, waves, gulf stream, thunder, etc.) and from the emerging hydrogen solutions. The possibility of a new kind of decentralised sustainable energy production based on the locally distributed sources of energy is on the horizon.

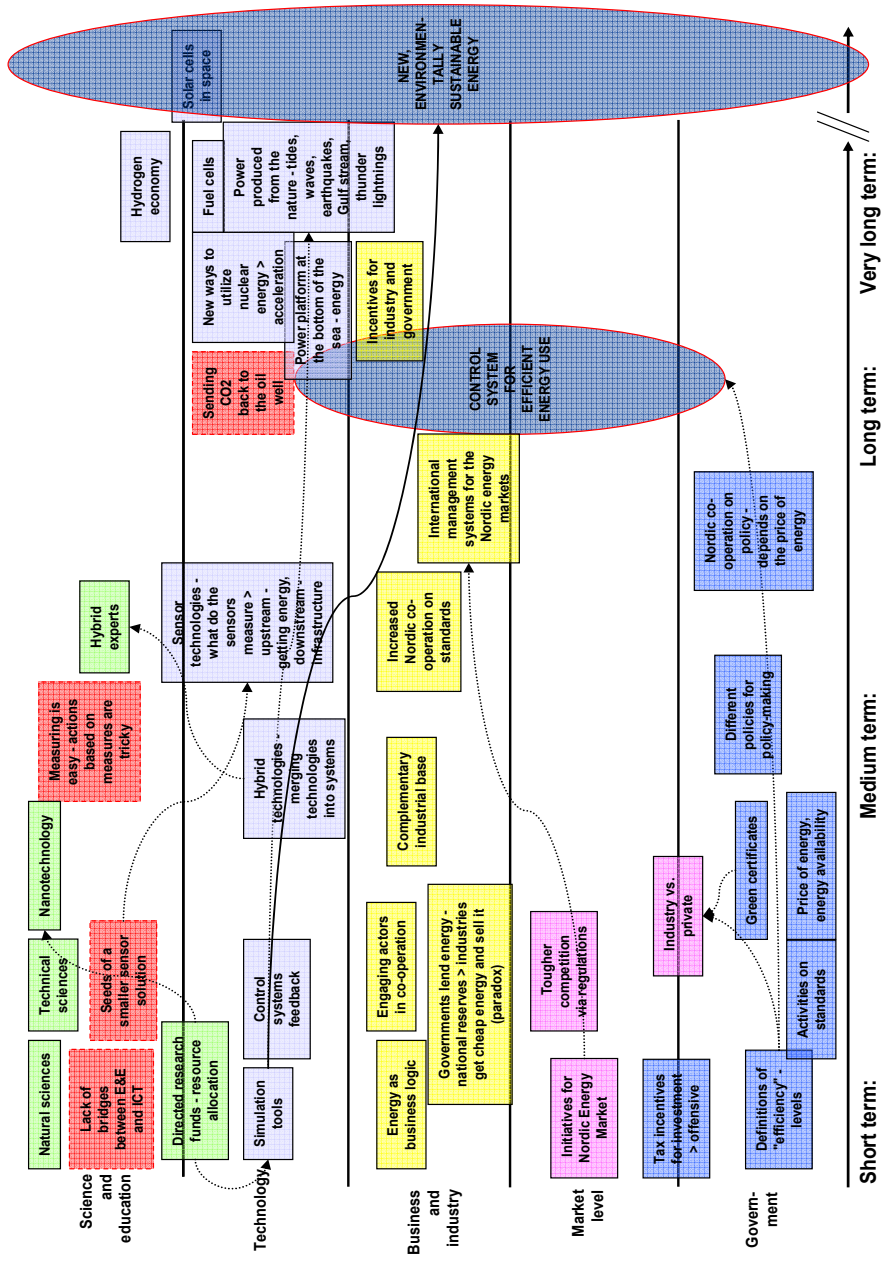


Figure 19. Production economy roadmap 1 – Control system for environmentally sustainable and efficient energy use.

7.2.5 Security – ICT for Security's Sake scenario

The roadmaps for security were constructed in the ICT for Security's Sake scenario. In short, this scenario describes a very security-driven development of ICTs. In the scenario, Europe and the US are in a close business and policy cooperation in the GWOT. There are strong alliances between the centralised political power and ICT development. The Nordic countries are tightly connected in this framework. Russia is a strategic partner of this coalition. The ICTs are developed in a strict homogenised fashion by one key player, "transnational MS". Many telecom companies and SMEs are under pressure since there are incentives to create a single secure software platform.

The expert group in the roadmapping workshop proposed quite a lot of visions for this theme (see Appendix D). Two visions were highlighted after the prioritisation: a secure management system for energy and a personal traffic agent for security. Two roadmaps were made on these topics (Figures 20 and 21). The first roadmap has a correlation with the previous energy roadmap in the production economy theme. This secure management system roadmap puts more emphasis on the security issues than its counterpart in the production economy. It is also a somewhat system-oriented roadmap. The second roadmap, a personal traffic agent for security, takes a more application-oriented and hence potentially disruptive view of the future by envisioning the ICT developments in the context of a traffic system.

Roadmap of secure management system for energy. In the *short term* (1–5 years) the simulation and energy awareness is accentuated on the science and education level. This includes the considerations of alternative energy sources and learning from the "benchmarking exercises" of the energy delivery problems. The simulation model could be utilised to prognose and model different kinds of crisis scenarios in the energy system. The government engages in political initiatives to endorse the emerging simulation developments and creates plans for the protection of platforms, plants and infrastructures. From the business and market point of view, the key question focuses on the acceptability of the proposed standards. This simulation view creates an energy crisis management system part 1. In the *medium term* (5–10 years) the energy crisis management system evolves into its next phase, which is based on an ICT-

driven decentralisation. It is assumed that the need for the local energy solutions is enhanced and hence the system is composed of local points that are knitted together with integrating ICT platforms. This decentralised system calls for new kinds of political cooperation processes on the Nordic level. Strong cooperation between governmental and business levels is also required. In the *long term* (over ten years) the energy crisis management system evolves into part 3, which is the phase of internationalisation. The workshop participants produced some innovative ideas concerning, for example, a UN energy convention and global foundation – here the "Bill Gates Foundation" since the scenario accentuated the role of big lock-in players – for the coordination of the internationalisation. In the *very long term* (over 15 years) the crisis management system could evolve into a new kind of security solution platform based on developments in new energy sources, international actor networks and robust infrastructures.

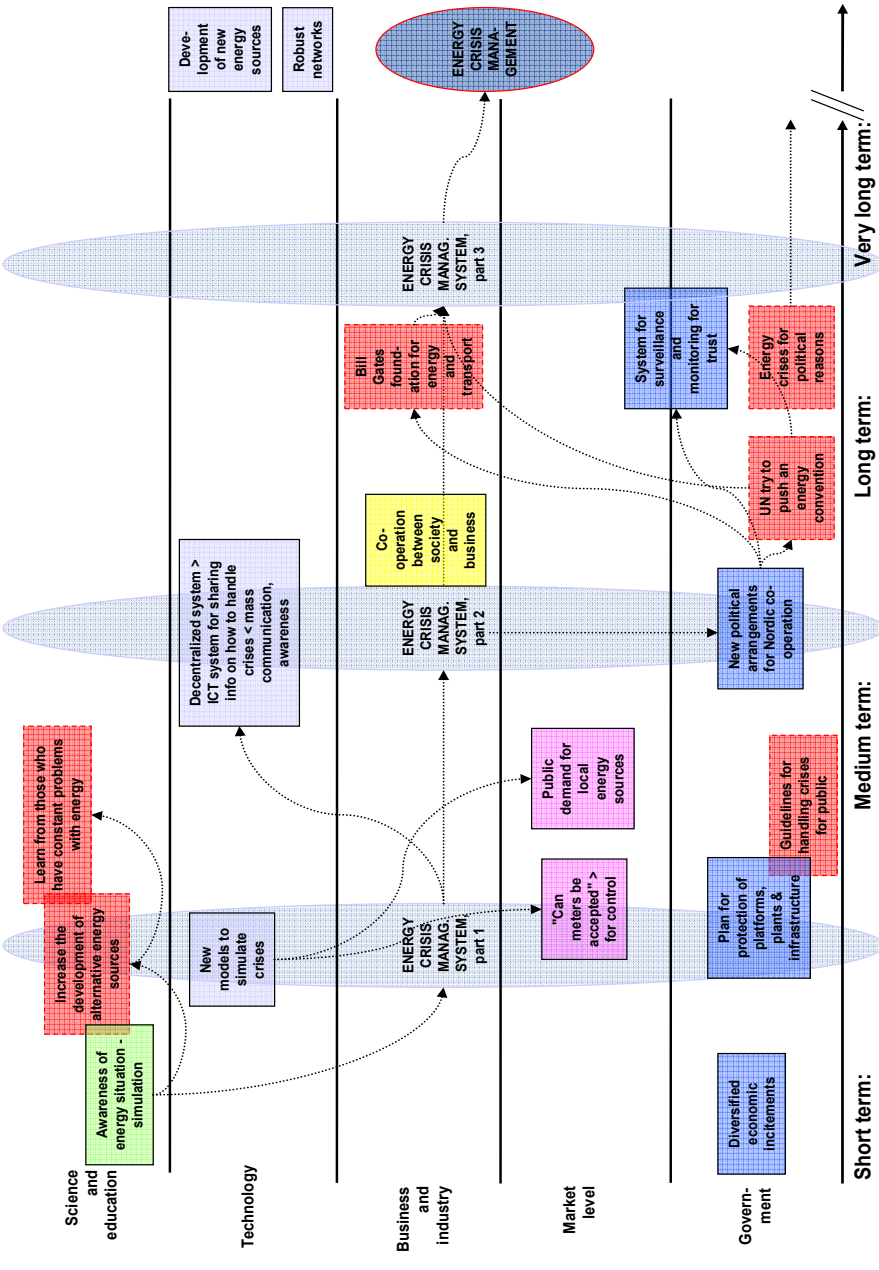


Figure 20. Security roadmap 1 – Secure management system for energy.

Roadmap of personal traffic agent for security. In the *short term* (1–5 years) the starting point for the development of personal traffic agents lies in the simulation solutions. On the technology level the key developments are in the system integration of somewhat immaterial and fast pace ICTs and more concrete and slowly changing traffic infrastructures. Other technological applications, such as machine sight and tactile coordination techniques, are prerequisites for the development of the personal traffic agent. On the market level, because of the security-driven scenario, the key idea is to sell safety and sustainability, i.e. less polluting, cost-, energy- and time-efficient transport solutions. On the government level the initiatives for 0-vision, standardisation and price regulation are required. In the *medium term* (5–10 years) there should be simulation labs to guarantee the "certificates" for the different traffic agent applications. On the technological level the keys are safe architectures and system integration, the creation of short-range ad-hoc networks with fluid interfaces to manage the information flows and interactive remote controls for speed. On the market level there would be a standard mark of "trustworthy" applications fulfilling certain security requirements and standards. It is speculated that in the medium term the basic innovation of the personal traffic agent would be developed. The energy issues are major drivers in the development of this application. The idea of the personal traffic agent is to optimise the traffic flows and make them time-effective and, especially, energy-effective. After the development of a traffic system with embedded agents, one needs new kinds of skills to be able to function in the system. Therefore, the formation of a new kind of driver's licence was proposed in the workshop. In the *long term* (over ten years) the technological level has probably reached the sophistication for robust functioning with embedded ICTs in it. On the business level all kinds of new potential is emerging. For example, the formation of an intelligent vehicle pool for different purposes might prove to be a new business model. Solutions for pilot logistic management might be possible sources of revenues. The personal traffic agent system could be developed towards a system with some export capacities. In addition, new kinds of exchange markets for the traffic agents might emerge.

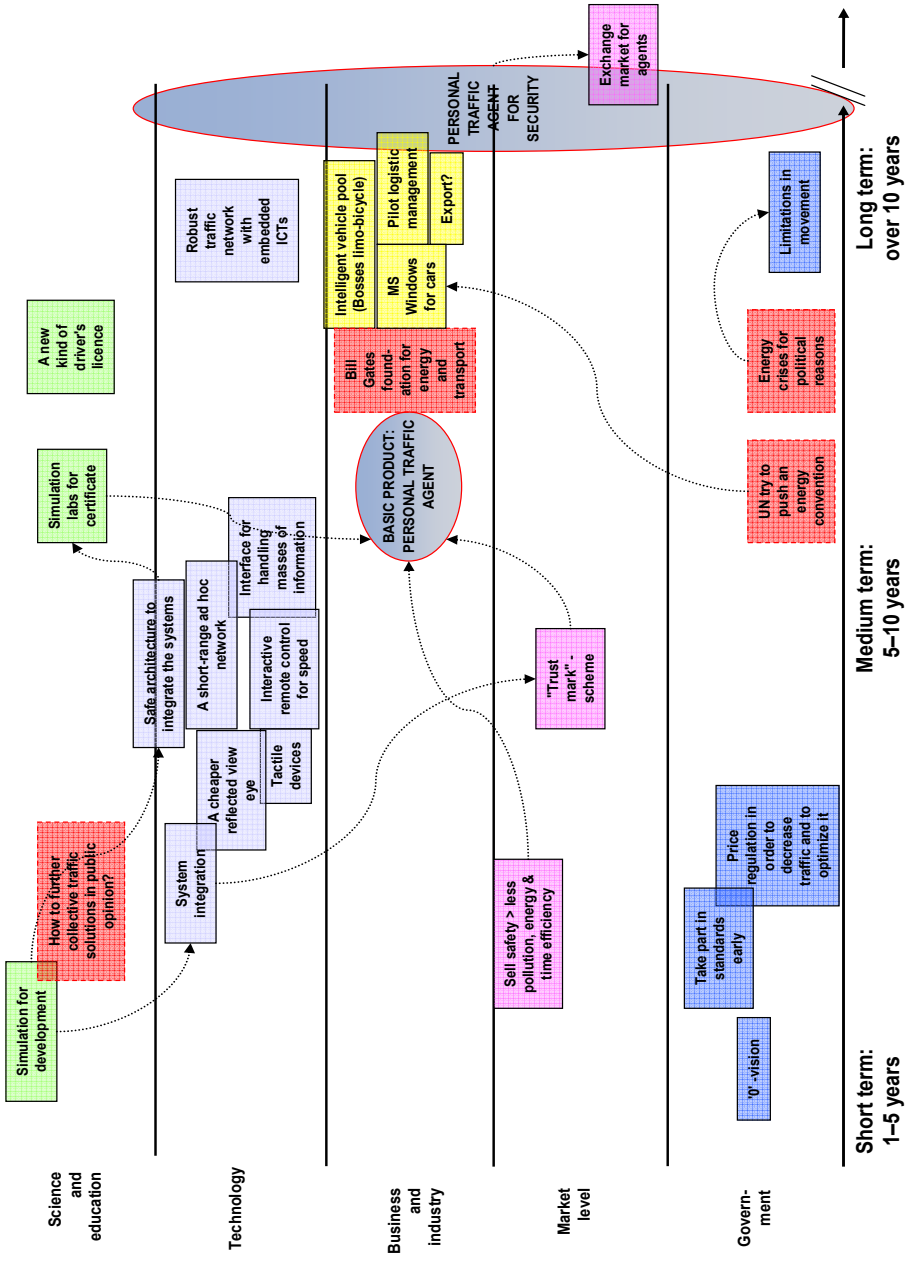


Figure 21. Security roadmap 2 – Personal traffic agent for security.

8. Actions on the Nordic level

8.1 Action workshop process

The action workshop was held in Oslo in November 2006 and focused on possible future actions and actors of the Nordic policies around ICT applications and innovations. The aim of the action workshop was to identify and evaluate a set of actions and policy alternatives to be taken by the key players in the Nordic countries in order to support the desirable developments and successful implementation of new ICT solutions. The workshop was built on the basis of the preceding phases of the project. It consisted of a short presentation of the project, thematic presentations and two groupwork sessions. This chapter presents a brief overview of the workshop process. The participants' names and organisations can be found in Appendix A.

Delta analysis. In the first groupwork the aim was to construct an overall picture of the scenarios and their effects on the Nordic actors and activities (Figure 22). The scenarios were elaborated with delta analysis, which means the creation of storylines and events connected to the specific target years (deltas). The working groups were divided by the scenario structure (first group – scenario 1, second group – scenario 2, and so on). The groupwork process was divided into steps 1 and 2. In step 1 the participants were to create a plausible outcome for the scenario based on the scenario manuscript. A plausible outcome for the scenario referred to the same thing as vision, but the word "outcome" was used because in this workshop the word "vision" referred to the future ICT applications.

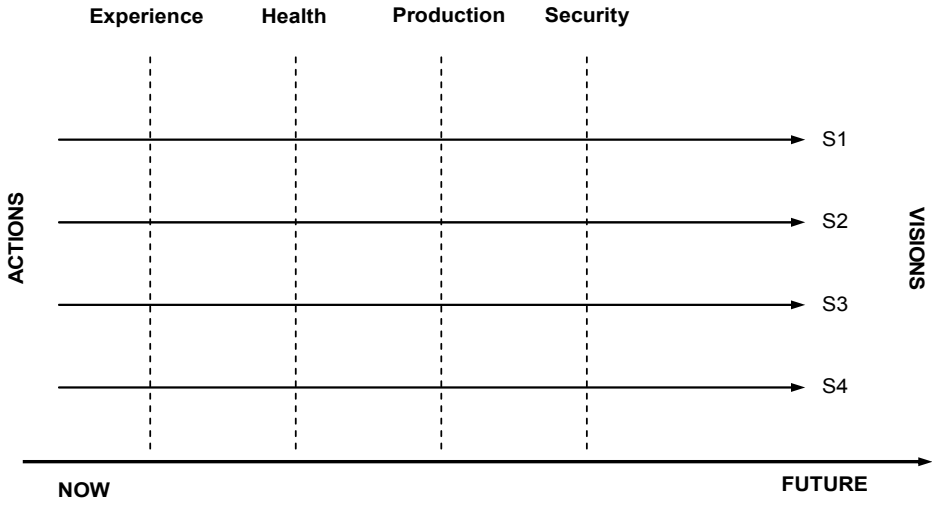


Figure 22. The general idea of the action workshop.

It was stated that the outcome should be related to the Nordic ICT Foresight themes (ICT applications in experience economy, health, production economy and security). In step 2 the participants were to construct the plausible storylines (deltas) for the chosen milestone years (2007, 2012, 2017, beyond 2017) for each scenario. It was further clarified that the storylines did not have to be "stories with a plot" – it was enough that the participants listed the most important factors according to the column topics. The groupwork process was done with specific matrices that were constructed for this purpose. The delta analysis applied in the workshop is presented graphically in Figure 23.

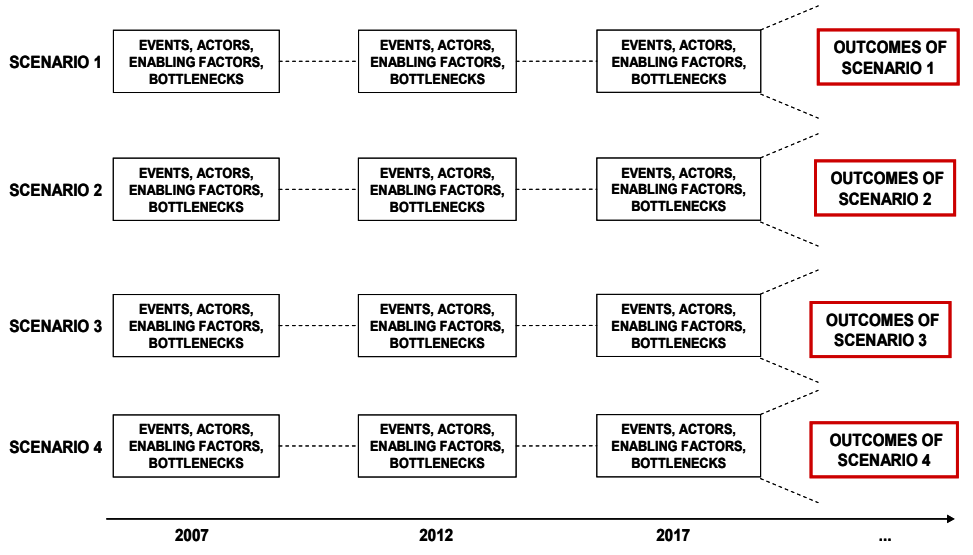


Figure 23. Delta analysis as applied in the action workshop.

Nordic ICT Foresight themes and scenarios. In the second groupwork the aim was to construct Nordic level action proposals on the Nordic ICT Foresight themes. This time the participants were divided by the Nordic ICT Foresight themes rather than scenarios. The task, given in three steps, was challenging. In step 1 the groups were asked to produce plausible socio-technical visions that would "enhance the Nordic productivity and well-being" in a given scenario in the year 2017. Three options were given: 1) to directly use the visions produced in the earlier phases of the Nordic ICT Foresight or 2) to elaborate the visions produced earlier or 3) to create new ones. In step 2 the groups were to choose one socio-technical vision (her refers to wide socio-technical issues or plain ICT applications) per scenario to work with in step 3. The criterion for selection was that the chosen vision should be the most plausible one in a given scenario. Again, the plausibility of the socio-technical vision is judged by the members of the group. In step 3 the groups filled the specific action matrices in order to construct the content of the scenarios. The target was to identify Nordic level enablers and bottlenecks for the action in question. Figure 24 presents the idea of groupwork 2 in graphic form.

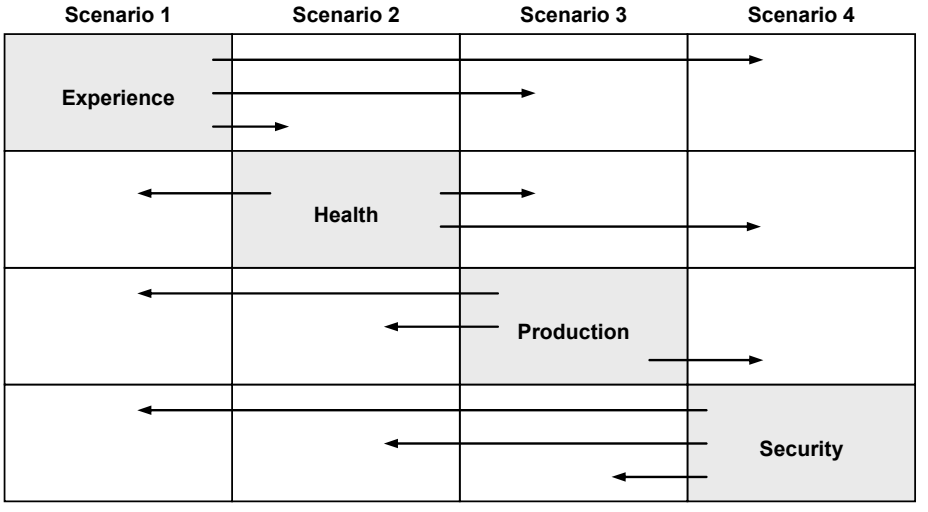


Figure 24. Translation of the themes into scenarios.

8.2 Outcomes of Nordic ICT Foresight scenarios

This part presents the first-hand results of the first phase of the action workshop. As was discussed earlier, the participants had created plausible outcomes for the scenario based on the scenario manuscript in the first step. In the second step the participants constructed the plausible storylines (deltas) in the short and medium term for each scenario.

8.2.1 ICT for Security's Sake

The first scenario in the delta analysis is the ICT for Security's Sake, which emphasises security-driven ICT applications. The general idea of the scenario emphasised the growing importance of security on every level of society. The first phase of the work dealt with the identification of specific outcomes of the possible realisation of the scenarios. The drafted outcomes are presented in Appendix E. The key ideas behind the drafting of the outcomes could be summarised in the following fashion:

- The scenario "ICT for Security's Sake" will lead to a situation where ICT development is slow and where development efforts are monitored. Strict regulations create solutions and user groups that oppose the monitored developments. Big enterprises create their own secure networked structures, co-nets.

From the drafting of the outcomes the workshop proceeded towards the delta analysis. The combinations of deltas, i.e. specific phenomena, enabling factors and bottlenecks in this scenario are presented in Table 35. It can be concluded that in the *medium term* the scenario could lead to harmonisation and creation of international co-operation laws on security. In general, the development of a regulatory environment is the key. In a geopolitical sense this could mean close cooperation between Russia and the EU and a kind of static lock-in situation in the Middle East. The drivers of the developments in the short to medium term would be energy questions, intensified global war on terrorism and harmonisation of democratic principles between EU–USA–Russia. In the *long term* the partial collapse of the public Internet is looming on the horizon. Due to viral attacks and infoterrorism, the public Internet has become critically unstable. Because of the unstable developments, the EU or sub-regions within the EU, e.g. the Nordic region, could develop closed co-operation nets (co-nets) with public and business actors. The key driver in this development is the difficulty in the creation of a hierarchical, top-down Internet. In this scenario the Nordic countries would lead the developments based on partially connected local nets.

Table 35. Summary of the delta analysis in scenario 1 – ICT for Security's Sake.

Medium term (1–10 years)	Long term (10–20 years)
Phenomena	***Phenomena***
• Development of regulatory environment: "patriot act" in the EU • Harmonisation and creation of laws on international co-operation • Russia in close cooperation with EU • Lock-in situation in Middle East • Infoterrorism is rising	• Partial collapse of public Internet > Internet is unstable, closed for 1–2 days in every month • EU developing its own more closed co-operation nets (co-nets) with public and business actors
Drivers	***Drivers***
• Energy questions • Global war on terrorism • Harmonisation of democratic principles between EU/US and EU/Russia	• Difficulties in building hierarchical, top-down Internet > Nordic countries are leading the development based on partially connected local nets

8.2.2 Nordic Mystique

The second scenario in the delta analysis is Nordic Mystique. The outcomes of scenario 2 can be wrapped up in the following way:

- Nordic Mystique is an open source welfare scenario. The Nordic model of a welfare society is globally followed. The key idea is the equal distribution of welfare that is driven by the technological motors. In this scenario the developments might even lead to a sort of "technomania" based on an extremely open ICT environment. The Nordic countries export products that combine ICT and welfare and policy ideas, e.g. eGovernment and eHealth. The Nordic model is in tight cultural competition with other societal models, e.g. neoliberal and rising "tiger models" in China and India.

The narratives produced in the delta analysis are presented in Table 36. In the *medium term* there will be business concepts created on the basis of Nordic values and models – Nordic organisations consult other countries on building the education and innovation systems. Nordic actors will be strong exporters of all kinds of user-generated concepts and OS software. On the Nordic governmental level there are initiatives for the fostering of trust in OS model. On the EU level there are initiatives for tightening cooperation with Chinese companies. The EU could also play a strong role in the construction of an environment and infrastructure for OS by initiating regulation that limits the standards and strives for the formation of critical masses in R&D and business. The drivers in the medium term are the OS model-based services that will be the growth platform for new firms. The societal need to make a more cost-effective infrastructure is key driver if Nordic firms are engaged in the creation of it. It might as well be the other way around: Asian firms might bring the most efficient solutions in this genre. Transactions could be partially based on goods and services, which creates a basis for the different strategic alliance models. One key driver in the medium term is the flat organization structures in the Nordic countries and advanced markets. The key bottlenecks, with the above-mentioned challenge from Asia, are the seemingly static and locked cultural heritage and accumulated wealth, which might slow the development practices.

Table 36. Summary of the delta analysis in scenario 2 – Nordic Mystique.

Medium term (1–10 years)	Long term (10–20 years)
Phenomena	***Phenomena***
• Nordic actors: export basic educational software to China and other countries • Initiatives for solving the issue of people being constantly monitored by technologies > in order to foster the trust in OS model • EU: Initiatives for co-operating with Chinese companies • EU should play a stronger role in the construction of an environment and infrastructure for OS > limitation of standards, reaching the critical mass • Environment: initiatives fostering environmental technologies in the traffic infrastructure • Business concepts created on the basis of Nordic values and models > consulting other countries on the education and innovation system	• China is the leading global power • China utilises Nordic countries as a test lab > China fosters open source model? (+); China fostering the concept of ambient intelligence and ubiquituous networks for monitoring and political control? (-); Nordic-Chinese test labs might be located in China (-) > Chinese centres in the EU and Nordic centers in China (+) • EU: Establishes a standard OS development that will become universal • Creation of environmental technologies in the Nordic countries • India: software and services giants > combinations of OS, gigantic firms and neoliberal idea of "democracy" > "Indian mystique"
Drivers	***Drivers***
• In the OS model the profit is made in services, consulting, etc. > possibilities for the new SMEs • Need for cheaper and lower cost societal infrastructure > possibilities for new kinds of business for Nordic firms • Transactions might not be based totally on money but on goods and services as well > barter-trade > strategic alliance models in business • Non-hierarchical innovation system > organisations are flat • Nordic countries tolerate taxes and new technologies (not common in other countries) • People adapt to the new technologies fairly easily	• The growth of the Chinese economy • Monitoring contributes to innovation and growth if it is not seen as a societally negative aspect and it has direct advantages (e.g. in traffic and health sectors)
Bottlenecks	***Bottlenecks***
• Nordic countries have a strong common culture and heritage based on, e.g., language • Need for cheaper and lower cost societal infrastructure > possibilities for new kinds of business > Asian firms will take over the potential • OS and Nordic welfare > Nordic societies become slow because of the already accumulated wealth	• Surveillance is not tolerated because it is approached as a negative factor to privacy • China-driven policies are not tolerated • American legal system • China–EU complex might leave the US out of the picture

In the *long term* the role of Asia is strongly accentuated. It is presumed that China will be the leading global power. In the long term the EU has established the OS standard that will become universal. Because of the open source spirit of the scenario, it is assumed that there will be strong development and business linkages between China and the Nordic region, especially in the field of advanced research services. For that purpose, China builds test labs with the Nordic countries to develop OS business models. This brings a lot of possibilities for the fertile Nordic SME landscape. The development will be a somewhat double-edged sword – on the one hand China fosters the open source model in its research and development, on the other hand the developed

ubiquituous networks in the country are used for governmental monitoring and political control. The Nordic test labs and Nordic centres are mostly located in China, but there will also be Chinese centres in the Nordic countries and in the EU. The growth of the Chinese and Asian economy is still the most crucial driver of the economy. It will be a particularly important driver for the creation of environmental technologies in the Nordic countries. Besides China, India will be the second nexus of the world economy. India's economy is based on gigantic software and service firms. All in all, the Indian model is a kind of variation of the "mystique" in the Nordic region – it is based on a combination of OS thought, gigantic software and service players, and a kind of neoliberal idea of "democracy".

The most important drivers of the development are to be found in the dynamics of the Chinese economy. In addition, it is also presumed that ubiquituous monitoring mechanisms will be drivers if these have directly approvable solutions, e.g. in traffic and in health, and they are not implemented in society by force, against societal attitudes. The probable bottleneck of the development is the above-mentioned issue of surveillance if it is implemented without a decent societal and ethical dialogue. Another bottleneck might be the fact that China-driven policies are not tolerated in the EU. The question of the US might also act as a bottleneck: the American legal system, especially in patents and protectionist tariffs, might prove to be a bottleneck. In addition, the scenario might lead to a situation where the US is somewhat out of the Asia–EU development complex.

8.2.3 Elite User's Paradise

The third scenario in the delta analysis was Elite User's Paradise. The outcomes of scenario 3 can be summarised in the following way:

- The scenario portrays a globally fragmented and class-divided society. The characteristics of the scenario are social tensions between the polarised social groups. The elite users have tailored applications and entertainment – other factions of society will have to settle for standardised low-key services. The scenario opens up potential for the Nordic region as "the choice of the elite": business opportunities within specialised solutions. The strengths of the Nordic region are in energy-efficient solutions, healthcare solutions and quality of living and design. New applications are developed and implemented on the Nordic level, but the production takes place in the low-cost countries. IPR secures the income.

In the delta analysis (Table 37) the most important phenomenon was the transformation of public healthcare towards privatised services, where the competition for applications creates strong economic dynamism. In the *medium term* the most important drivers are EU programs with a focus on eHealth and international private service providers. The key bottleneck in this development trajectory is the Nordic social governmental model. In the *long term* there will be reduced per capita expenditure on health, patented standards and protectionism, and private value added service providers. An interesting driver sketched in the workshop was the idea that you would have to pay for your privacy. Bottlenecks in the long term would be the lower innovation levels that are the result of the slow down in the global economy. The standardised solutions might also act as bottlenecks.

Table 37. Summary of the delta analysis in scenario 3 – Elite User's Paradise.

Medium term (1–10 years)	Long term (10–20 years)
Phenomena	**Phenomena**
• Transfer from governments', "free" healthcare to privatized services • More and more private health services	• Reduced per capita expenditure on health • Proprietary standards and protectionism • Private value added service providers
Drivers	***Drivers***
• EU programs with a focus on healthcare and ICT • International private service providers	• Public services "big brother is watching you", pay for privacy
Bottlenecks	***Bottlenecks***
• The Nordic social governmental model	• Lower innovation resulting from slow down in global economy • Standardised solutions (governmental actions)

8.2.4 Big Business Lock-In

The fourth analysed scenario was Big Business Lock-In. The outcomes of this scenario can be summarised as follows:

- The scenario depicts an ICT future dominated by big players. Standardised ICT applications are produced to a large share of the population with maximum profit. The Nordic region works as a test market for early goods for mass production. De facto standards exist in ICT Health applications and e-learning. In the Nordic countries in particular there are activities to create segmented and tailored products for the "underground", i.e. users with needs that differ from the larger share of the population.

The phenomena gathered in the delta analysis (Table 38) emphasises digitalisation of media content. In the *medium term* it is presumed that the Nordic countries start the digitisation of all media through a coalition of government, publishers and content providers. The drivers for this development are the ensuring the free supply of school books and material that needs frequent updating. The bottleneck in the development is the small market. In the *long term* the most important outcomes of the scenario are the developments in the standard online communication procedures between doctors and patients. These procedures give opportunities for the service provision companies in health communication. The driver for this is the large public health sector. Non-compatible systems act as bottlenecks.

Table 38. Summary of the delta analysis in scenario 4 – Big Business Lock-In.

Medium term (1–10 years)	Long term (10–20 years)
Phenomena	***Phenomena***
• Nordic countries start digitising all media content > government, publishers, content providers	• Online communication with patients as standard product/procedure > health companies
Drivers	***Drivers***
• Free school books, advertising, demand for frequent updating	• Large public health sector
Bottlenecks	***Bottlenecks***
• Small market	• Non-compatible systems

8.3 Actions in Nordic ICT Foresight themes

In the second phase of the action workshop the experts were asked to produce action proposals in the Nordic ICT Foresight themes – experience economy, health, production economy, security. The first part of the task was to define future-oriented, yet plausible, actions for each theme. The task was to depict the content of the action and, on a quite general level, to define the possible actors that could be realising the action. Furthermore, the socioeconomic drivers and bottlenecks for the actions were the defined. Tables 39, 40, and 41 present summaries of the elaborated actions. These elaborated action proposals can be, as such, utilised as guidelines for the Nordic level policies. In this publication the action proposals were used as "food" for the creation of general Nordic level policy recommendations in the Nordic ICT Foresight core group. These policy recommendations are presented in the final chapter of this publication.

8.3.1 Elaborated action proposals

In the working process, the participants first brainstormed the plausible socio-technical visions (see Appendix E). These socio-technical visions formed the basis of the action proposals. The elaborated action proposals are presented in the following tables – Table 39 presents the action proposals for the experience economy theme, Table 40 for health and Table 41 for the production economy. Security was left a bit unelaborated because of the time limitations on the workshop. The key issue to notice is that the action proposals were produced in the context of scenarios. This procedure aimed at gaining more depth in the scenarios. It also made the process quite hard and demanding for the experts – thinking within the scenario framework is not easy task, even for an experienced facilitator.

Table 39 presents the results of the work on the *experience economy*. In the workshop there was some discussion on whether the group should choose a different socio-technical vision for different scenarios or should the group work with the same vision in different scenarios. In the end the group worked with a kind of combination of the two. The generic idea of "electronic space" was chosen as the combining element between the scenarios, but in each scenario some unique characteristics of the "electronic spaces" were identified. Within the framework of scenario I *(ICT for Security's Sake)* the elaborated actions were 1) applications for simulating threats (i.e. virtual spaces, games, simulators), and 2) the creation of an ICT-bio-identifier for the access to different eSpaces. It was further characterised that this application could be based on scanning the eye. Within the context of scenario II *(Nordic Mystique)* the elaborated action proposals were 1) applications for user-driven innovation processes in industries and research areas, and 2) digitalisation of the cultural heritage of small languages. In the second proposal the idea was to form a loose network of Nordic actors to form a public-private-style coalition to realise this issue. Within the framework of scenario III *(Elite User's Paradise)* the action proposals were 1) the creation of extremely sophisticated smart e-spaces for the elite users, 2) creation of moderately smart e-spaces for the different hobbyists, and 3) closed e-spaces for the value-driven communities. The ideas for these e-space proposals were inspired by the narrative of scenario III, which emphasised the polarised user groups. Within the framework of scenario IV *(Big Business Lock-In)* the action proposals in the experience economy theme were 1) franchising the

standard models of the big companies, and 2) customisation of the standard products for the niche markets.

The action proposals in the *health* theme are presented in Table 40. The socio-technical visions discussed in health circled around the issues of a single Nordic health market, a personal health card, home medicine applications and early warning systems for elderly home care (Appendix E). Within the context of scenario I *(ICT for Security's Sake)* one action proposal, a single Nordic market for healthcare ICTs, was discussed in two steps: 1) a broadly initiated design process on a Nordic level, and 2) establishing a common platform for searching for suppliers/providers of services. Within scenario III *(Elite User's Paradise)* the elaborated action proposal covered the issues of preventive healthcare, health monitoring, and personal healthcare/preventive medicine for the elite users. It was stated that the idea was to provide advanced ICT-based systems of "ideal healthcare" for the elite and simpler systems for the general market. Within the context of scenario IV *(Big Business Lock-In)* the discussion was targeted at the outsourced medical services – a kind of simplified version of the elite health systems provided by large private operators – to be sold to the general public.

The action proposals in the *production economy* are shown in Table 41. The group discussed different possible socio-technical visions and worked with the following visions: Barents on screen, new digital management, home automation and convergence of information systems. Within the framework of scenario I *(ICT for Security's Sake)* the elaborated action proposal was context-aware systems/applications with surveillance of production and the environment (Barents on screen). It was to be realised in three steps: 1) improving logistics, 2) producing new regulation, and 3) engaging in actor-oriented dialogue on the ethical and business consequences of these monitoring systems. The action proposal within the context of scenario II *(Nordic Mystique)* highlighted the new digital management. The new ways of digital management were seen to be realised in three steps: 1) implementation of "open innovation" in the production economy, 2) setting criteria to ensure quality digitally, and 3) measuring output/performance. Finally, within the framework of scenario III *(Elite User's Paradise)* the action proposal discussed was home automation. In the action workshop this action was initiated in three steps: 1) implementation of energy-saving systems, 2) formation of intelligent security systems, and 3) activities to create innovative entertainment systems.

In the fourth theme, *security*, the group discussed five possible visions to work with: 1) co-nets (isolated internets): the possibility to build secure nets for specific purposes, 2) a security and management system for energy, 3) a security and management system for water supply, 4) a personal traffic agent for security, and 5) a digital version of the cultural content for small language areas. The drafts of the actions are presented in Appendix E. Some important generic technologies within the context of security were also discussed. These were cryptographic technology, biometrics, sensors, and system architectures for systems based on open source. The elaboration of the action proposals was not finalised in the security theme.

Table 39. Summary of the action proposals in the experience economy.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
EXP. ECONOMY	***I: ICT for Security's Sake***	**1. Applications for simulating threats** > virtual spaces, games, simulators **2. ICT-bio-identifier for the access to different eSpaces** > sophisticated application based on, e.g., scanning the eye	**1.** Business, government; Nordic joint venture combining public & private **2.** Co-operation between research and SMEs	**1.** Atmosphere of insecurity; security is central part of everyday life **2.** Because of the theft identities, organisations need identifiers; market demand in US and more unstable developed countries; the instability in the outer world makes the Nordic countries more attractive	**1.** "Security" could be understood too widely > it is taken for granted; too many initiatives under the broad concept of security > losing focus **2.** Theft of identities > you cannot use any identity because of the possible thefts
	II: Nordic Mystique	**1. Applications for user-driven innovation processes** in industries and research areas **2. Digitalisation of cultural heritage of small languages** > Pre-study and a Nordic demo to invite private companies to develop services	**1.** Nordic SMEs and larger firms, EU research programs **2.** A pan-Nordic actor for front figure; government and State (university libraries and national libraries); Publishers; Business	**1.** ICT can be a general trend in all the industries; Nordic countries are very developed in ICTs > coverage in ICT equipment; Nordic mindset is ripe for these kinds of solutions **2.** Need to conserve cultural data in digital form; A common platform; development of services	**1.** Too specialised competences > need for cross-cutting and multi-disciplinary competences; cultural difficulties in changing production practices **2.** Political will; funds; conservatism in copyrights; suitable business models; bottlenecks in public–private partnerships
	III: Elite User's Paradise	**1.** Creation of extremely sophisticated **smart e-spaces** for the elite users **2.** Creation of **moderately smart e-spaces** for the different hobbyists (semi-Ikea products) **3. Closed e-spaces** for the value-driven communities	**1.** Firms, researchers, exclusive networks (executive clubs) **2.** Enthusiasts from the different branches **3.** People who have a value-driven cause	**1.** Technological developments in ICTs; elite users are driving the innovation processes in the smart training **2.** Technological developments in ICTs; interest in the different branches (e.g. motorcycles, horses) **3.** Value differences in society; in a free society you are able to create value-driven networks; value differences drive the use of ICTs (e.g. it is more environmentally sustainable to use ICTs)	**1.** If you are not part of the elite, you have no access > where's the critical mass? **2.** Exclusive clubs that are divided by interests **3.** Some of the e-spaces are not allowed for all of the users
	IV: Big Business Lock-In	**1. Franchising the standard models** of the big companies **2. Customisation of the standard products** for the niche markets	**1.** Nordic firms **2.** SMEs	**1.** Cost-efficiency of the standard models; simple to use; large export opportunities in developing regions; big companies outsource non-core operations **2.** Volumes are too small for big companies	**1.** Lack of trust in the monopoly solutions and monopolies themselves; standard models are not commercially exciting; boring selection of goods **2.** Only to be done with the permission of big firms

Table 40. Summary of the action proposals in health.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
HEALTH	***I: ICT for Security's Sake***	**A single Nordic market for healthcare ICTs** **STEP 1.** Broadly initiated design process on a Nordic level **STEP 2.** Establishing a common platform to search for suppliers/providers of services	**STEP 1.** Collaboration between responsible parties: government, hospitals, representatives of patient groups, research institutes **STEP 2.** Government	**STEP 1.** Society interested in reducing total health costs and enabling better coordination **STEP 2.** EU regulations; common data card for all EU inhabitants	**STEP 1.** Strong organisations, different issues, solutions, regional hospitals on their own agendas **STEP 2.** Too complex in structure and technologies
	III: Elite User's Paradise	**Preventive healthcare, health monitoring, personal healthcare/preventive medicine for the elite users >** An exclusive private market offer of advanced ICT-based systems for "ideal healthcare"; "second rate" simpler systems for the general market	Privatised smaller clinics supplying "high-class" service for wealthy clients	Lack of capacity in the public health service	General acceptance of private services
	IV: Big Business Lock-In	**1. Outsourced medical services** > Advanced systems too expensive to be applied in general. Simple versions of health systems provided by large private operators	**1.** Few large suppliers of systems and health services	**1.** Financial strength of the few companies having legal access to the health market	**1.** Lack of user acceptance for the complex system or lack of facilities in the system

Table 41. Summary of the action proposals in the production economy.

THEME	SCENARIO	ACTION	ACTORS	DRIVERS	BOTTLENECKS
	I: ICT for Security's Sake	**Context-aware systems/applications with surveillance of production and environment (Barents on screen)** **STEP 1.** Improving logistics **STEP 2.** New regulation **STEP 3.** Dialogue on ethics and business	**STEP 1.** Oil companies **STEP 2.** Government (national, EU) **STEP 3.** NGOs, environmental groups, companies	**STEP 1.** Development of context-aware technology enablers **STEP 2.** Climate changing, rising awareness **STEP 3.** Big environmental accident (big oil spill)	**STEP 1.** Cost and availability; integration **STEP 2.** Cost, profit making large companies **STEP 3.** Complexity of the question, conflicting interests
PROD. ECONOMY	***II: Nordic Mystique***	**New digital management** **STEP 1.** Implementation of "open innovation" **STEP 2.** Setting criteria to ensure quality **STEP 3.** Measuring output/performance	**STEP 1.** Dynamic and ever-changing peer-to-peer/ business networks **STEP 2.** Project owner, participants **STEP 3.** Private and public employees/employers	**STEP 1.** Open ideas approach, open idea auctions **STEP 2.** Common idea of project **STEP 3.** Creative knowledge work	**STEP 1.** Need for new platforms for co-development **STEP 2.** Individual preferences **STEP 3.** Need for new definitions of performance, problem of existing systems
	III: Elite User's Paradise	**Home automation** **STEP 1.** Implementation of energy-saving systems **STEP 2.** Intelligent security systems (home, health, etc.) **STEP 3.** Innovative entertainment systems	**STEP 1.** Energy industry, construction companies, ICT players, EU policy makers **STEP 2.** SMEs providing technology, health sector (private/public) Convergence of film and virtual reality	**STEP 1.** Energy price, sensor technology, energy awareness **STEP 2.** Demand and desire for more security, health sector efficiency	**STEP 1.** Public attitudes, (choice hotel/private person), reconstruction/renovation of housing constructions **STEP 2.** Integration of technologies

9. Policy recommendations

9.1 On the construction of policy recommendations

The key policy recommendations are formed and crystallised in this chapter. The research process is briefly "re-read" by highlighting two elements: 1) the common themes and idea threads that have prevailed throughout the process and across the Nordic ICT Foresight themes (experience economy, health, production economy, security), and 2) the most important themes and issues that seem to be the key dividing lines in the four scenarios. Therefore, this interpretation seeks to outline the most plausible development trajectories for the Nordic region that cross-cut the four Nordic ICT Foresight themes. On the other hand, the interpretation tries to identify some disruptive developments that could potentially be realised in each of the scenarios. The perspective of the formation of policy recommendation is the Nordic region – the policy recommendations are, therefore, directed to a quite general transnational level. However, the policy recommendations are written in a form that thrives to make the recommendations applicable on other regional (European, national, sub-national) and even organisational levels.

The key idea in structuring the policy recommendations is to divide them into *implementation strategies*, i.e. strategies that could be implemented on the Nordic level in order to produce new innovation dynamics in ICT or to find a new, potentially prosperous, production niche from the Nordic viewpoint. The implementation strategies are literally strategies that seem to be plausible to engage on the Nordic level. However, regionally robust implementation strategies are somewhat hard to find in some ICT-related production issues. Where robust strategies are implausible, one should seek *adaptive strategies*. These refer to strategic options that put the emphasis on the ways to cope and prosper in the overwhelming global "ICT streams". Through adaptive strategies one can find the best possible policy options in the face of global dynamics or find strategic "holes" – potential local alternatives to the global megawaves – that could be disruptive in the longer term.

9.2 Recommendations I: Implementation strategies

In this chapter we discuss possible implementation strategies that could be adapted on the Nordic level.

- **Creation of Nordic SME-based competence clusters and/or platforms in converging technological niches.** According to the results, one of these niches could be found in the development of **(1)** ***sensor-based enhanced reality systems***. This niche could be directed both to the professional applications requiring multi-sensory experiences and applications with more entertainment value. Professional applications could be multi-sensory learning and testing spaces that would combine sight, hearing, touch and maybe even smell experiences. Entertainment applications could be enhanced reality games that combine virtual elements in a physical environment. Smart training applications could also be further developed – home exercise equipment, virtual "trainers" and smart jogging tracks. These kinds of applications are already being developed at VTT. However, the niche competence cluster could be developed into a Nordic activity by combining the Finnish and Swedish mobile technology know-how with small firms developing games and social media applications (e.g. Sulake) and bringing into the structure the Danish world-class competences in the sound technologies. The second potential Nordic niche could be linked to **(2)** ***intelligent buildings and home automation***. In this case the direction would lead to technologies embedded in everyday environments. One of the directions could be to focus on energy-saving systems and home security systems. The third potential niche could be **(3)** ***development of mobile digital management applications especially for the production systems***. The core of this proposal is to foster development of mobile digital management applications in production systems, e.g. production lines and logistic chains. The key to this proposal is to concentrate on flexible interfaces (via mobile phone or laptop) and dynamic peer-to-peer networks. The key word is modularity, e.g. if the system detects a fault, it warns the operator before it happens and also reroutes the production line. In this way it could be possible to create more fault-tolerant production systems. The mobile management applications could also include elements of environmental measuring systems and services. This idea could also combine elements of user-generated content. In the context of mobile digital management applications a new

integrated way of thinking about a production system is needed. In this way of thinking the research and development, production and logistics are understood as an integrated process. The key technologies to further create such systems are RFID (radio frequency identification), IP-based (Internet Protocol) systems, new interfaces (tangible, wearable, embedded) and simulation applications.

- **Enhancing the utilisation of mobile ICT infrastructures for remote monitoring.** One of the potential policy proposals in this context could be a research initiative to create context-aware systems and applications for the surveillance of the environment, e.g. "Baltic Sea and Barents on the screen". The developed applications could be applied in the monitoring of peripheral geographical areas, in monitoring the general changes in the environment, or in traffic and infrastructure surveillance, or it could be applied in integrated production systems, "factory on the screen". Also, by combining the different technologies, e.g. sensors, terminals and mobile systems, the application could be used in the control and optimisation of the logistic system. The actors involved in the system should include governments, SMEs developing context-aware IC technologies, large oil companies, NGOs and environmental groups. In the longer time period new regulatory frameworks should be explored and encouraged on the Nordic and EU governmental levels.

- **Initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector.** The idea of niche test markets, especially within the context of the health sector, has been popping up along the two-year period of Nordic ICT Foresight. The aim of the initiative would be to form enough critical mass for the credible testing of the applications as well as to utilise the similarities and differences of the Nordic countries in the crafting and fine-tuning of the applications. The basis for the initiative is the acknowledgement that there are some integrating elements in the national health systems in the Nordic countries. There are also some diverse factors, but these should be seen more as potential in the creation of markets for flexible and tailored health applications. The test market approach could be important in searching for standards. The Nordic test market initiative should especially focus on three elements: (1) the creation of an integrated Nordic test market concept itself, (2) applications in distance medicine, and (3) probing the possibilities for the formation of a common

Nordic health card. The ICT-wise starting point for **(1) *the creation of a Nordic test market concept*** would be to formulate a somewhat common Nordic health record on how to store, handle and distribute the patient data. The first step would be to form a broad design process on a Nordic level based on the collaboration between responsible parties of government, hospitals, patient groups' representatives and research institutes. The second step would be to establish a common platform for searching for suppliers/providers of services. The second proposed angle is to make a platform for **(2) *the applications of distance medicine***. This would be a core function in the Nordic level home medicine and distance monitoring concepts and technologies. Some applications developed on this platform could include systems that monitor and assist elderly people living at home, applications for monitoring day-to-day activities (if, e.g., blood pressure is too low, a signal is sent to the hospital) and, in addition, ICT-based diet and nutrition systems. The actors participating in this platform could be Nordic health actors, governments, hospitals, ICT companies and patient organisations. The third proposed application in this context is **(3) *the formation of a common Nordic health card***. The formation of a health card requires the creation of an integrated health record system. The construction of the actual card could be based on mobile technologies. The idea is that citizens could have a smartcard in their wallet with their personal medical data. This card could activated via some biometric identification application. The Nordic dimension of the idea is that the health card would be valid throughout the whole Nordic region. In the first initial stages a lot of testing of the application would be needed. The key issue would be to ensure that the card is only available to health care institutions accredited by the State, not for insurance companies or other private organisations.

- **Nordic level research and policy initiative to develop new ICT-based concepts for information and general security.** The core of this strategy would basically be to present an initiative that aims at building a common Nordic agenda for the research, development and policy activities in the field of ICT security. The idea should be quite wide and, therefore, it should be based on the general notion of security that combines information security with social security and with environmental and network security. The technological basis for the system would be in ubiquitous technologies and in context-aware systems. In the Nordic ICT Foresight workshops there were a

number of visions and dialogues that are connected to this issue. Reflecting on these discussions, the key questions are: identity management, dynamic privilege management, long-term preservation of the data and non-reproducing technologies. The question of biometric identification is the core of the issue. Biometric identification combines a lot of technologies and practices, e.g. biometric tags, the question of security of the biometric information and the prevention of malpractices with the biometric information. The issue of open urban spaces should be high on the agenda, e.g. where and how to apply figure identification in a way that does not invade the privacy of the citizens. The workshops produced also some ideas on the network concepts for these developments. One idea would be to develop Nordic "co-nets", partially closed regions of the Internet that could be linked to the global system when needed. The catch in this idea is to form the co-nets in between organisations, because intra-organisational "co-nets" exist already. The crucial point in all these applications is to discuss and understand the ethical dimensions of the produced applications.

- **The ideation and creation of new business models for the user-driven application developments.** The quite egalitarian Nordic welfare society combined with relatively low societal hierarchies could be fertile ground on which to form business concepts to the "long-tail" of niche applications, on the basis of user and "amateur-driven" applications and ideas. In this context it is important to figure out the nature of the user-driven and "immaterial" applications. The key question for the business concept lies in the system of payment. In this case the key questions are: is the payment system closed, meaning that you pay for the key and the access, or open, meaning that you browse through a mass of advertisements to see the content? A potential Nordic niche could be to create ***advanced micro-payment systems and business concepts linked to user-generated products and business models***. These concepts should be future-oriented and seriously consider the already crucial issues of file sharing, IPR and digital rights management (DRM). In this context it is crucial to acknowledge that creative goods, for example games, DVDs, etc., are growingly transformed into integrated service concepts. This creates room for a variety of service brokering business models, such as adding value by managing user identity, profiling, billing and granting access to services.

- **The Nordic initiative to enhance electronic business transactions and applications.** The Nordic area is well developed in its information infrastructures, but there are some gaps in the utilisation of ICTs as a business platform. For example, in the Nordic e-business survey it was found that the potential in e-business has not been exploited as far as it could be in the Nordic countries. Also, in a recent Finnish Technology Barometer (Lehtoranta et al. 2007) it was acknowledged that there is still a lot to do in the development of e-commerce and digital communications in the consumer markets and in the business-to-business models. Besides, e-business functions are focused on large firms. Small and medium-sized firms should also be more tightly integrated into the development.

9.3 Recommendations II: Adaptive strategies

In mobile ICT, the Nordic region has been the advanced developer of solutions for about 15 years. The field of mobile ICT is changing radically in the waves and tides of global competition and the global marketplace. In this context, the Nordic countries could initiate three kinds of adaptive strategies.

- **Towards a deeper understanding of the cultural contexts of new services and solutions.** The leading mobile firms have for some time experienced some "cultural frictions" because of the enhanced encounters with new cultures, locations and rapidly evolving market segments. In culture and geography the challenge is to adapt to different markets and find the key to success. Many firms have solved this dilemma by moving the production nearer the potential markets, a process that has been notoriously known as the China phenomenon. This cultural and geographical market change can be called horizontal. However, there are also vertical market changes. The market segmentation also happens on the low-end, high-end continuum. In the low-end the cost-efficiency is the most important decisive factor. Low-end users buy the most cost-effective products with the basic technologies. In the newer markets, like China or India, the low-end might be an important gateway to the more advanced products as the living standards of the population increase. In the high-end the competition will be in the quality of services and usability of products. The high-end customers demand fluidity and coherence of services.

- **Learning to utilise and productise innovations in the second or the third wave.** In Nordic electronics and ICT production there has traditionally been a "settler" spirit: the core of the firms is based on the basic technological or business innovations. Some new aspects could be linked to this strategy: maybe some Nordic actor could be the top player in the bettering and moving of innovations. Not all the basic technology need be developed by the firms themselves – the additional strategy might be to find new niches and areas for the old innovations or bettering and smoothing the older innovations so that they could utilised in older market areas.

- **Widen the scope of innovation and learning to "recycle" the ideas into new niches.** In ICT and industry in general there is a need to identify the innovation as a more wide process than just developing a technology and making a product out of it. The innovations could be linked to the processes, to the brand, to the market segments or to the niches. Therefore, older technological solutions might be innovations in new areas.

- **Creating strategies for the utilisation of a "long tail" in the Nordic sphere.** The long tail – coined by Anderson (2004 & 2006) and referring to the "right end of a right-skewed distribution" (ETEPS 2007) – refers to the production and distribution of vast varieties of low-demand tailored products that can collectively amount to equal shares of market successes or "blockbusters". The idea of the long tail is to make small niche products for minorities in a mass-production fashion. The advanced Nordic ICT production technologies, energetic cultural industries – e.g. in music and multimedia – and flat "user-driven" societal models could enable application of this idea of "segmented mass customisation" in a variety of fields.

10. Summary

The Nordic ICT Foresight project was launched in May 2005 with research partners VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security.

There were five research phases (see Appendices). In the first phase, **1) desktop survey**, the boundaries of the technological field were defined. In this phase the major Nordic activities on ICT were mapped and related to issues within research, industry, finance and government policy in the Nordic countries. The second phase, **2) SWOT analysis**, identified trends in the national ICT business and research environment in the four Nordic countries: Finland, Sweden, Norway and Denmark. In parallel with the SWOT analyses the emerging technologies workshop was also carried out in VTT. In this workshop the key ICT applications and generic technologies were identified in the Nordic ICT Foresight themes: experience economy, health, production economy and security. The third research phase, **3) scenario and vision workshop**, had two purposes: to create a set of external scenarios in Nordic ICT applications and to produce a set of socio-technical ICT application visions. The scenario workshop produced a set of external scenarios for the socio-technical environment around ICT in the Nordic countries from roughly 2007 to 2017. This phase also produced ICT application visions, which were tested against the scenario set. The fourth phase, **4) roadmapping workshop**, created roadmaps on socio-technical visions on the levels of science and education, technologies, businesses and industries, markets and government. Some possible service and business opportunities and the most important enabling technologies were characterised from the material produced in this workshop. In the final research phase, **5) action workshop**, a set of actions to be taken by the key players in the Nordic countries were depicted. After the workshop the core team clustered and categorised the various actions into larger action fields, investigated how these action fields cope with existing policies, and identified key issues to take into consideration when realising actions.

The results of the **emerging technologies** workshop formed a robust background for the subsequent research phases. In the theme of *experience economy*, the most important applications are to be found in the areas of tailored service applications, network applications, hybrid media, communication services, voice and language-oriented applications, virtual environments and ubiquitous technologies. Other important application areas are also in technical solutions and entertainment. In the *health* theme the most important application areas are personal healthcare and home medicine, which was highly prioritised. Other important application areas are diagnostic and treatment applications, medical information processing, socially activating and assisting applications, applications for the control of allergies and documentation applications. In the theme of *production economy* the pivotal application areas are industrial production, industrial information processing, converging information systems, and simulation and management of the logistic chain. In the fourth theme, *security*, the key application areas can be categorised into general confidentiality and security in environments and networks and biometrics.

The key results of the **desktop survey** illustrate that there are significant differences in scope, scale and goals for foresight activities in the four Nordic ICT Foresight countries (Denmark, Finland, Norway, Sweden). The foci of the desktop survey were on the socio-economic drivers of change and challenges, on key technologies, on the descriptive nature of the reports and on their policy recommendations. In a generalised fashion it can be stated that the studied Swedish ICT material had strong descriptive socio-technical emphases, the Danish material combined descriptive technological emphases with societally flavoured policy recommendations, and the Norwegian material combined mainly descriptive technological and policy foci with some societal emphases. The Finnish material combined mainly descriptive technological foci with quite technologically-oriented policy initiatives.

Some Nordic level conclusions that cross-cut the Nordic ICT Foresight themes can be drawn from the national **SWOT analyses**. The Nordic countries have a lot of similarities in strengths, which emphasise ICT infrastructure, education levels and literacy. In addition, advanced markets are an important Nordic strength. The common weaknesses are the generally weak capacities to build commercial solutions from technological developments. Risk funding is also a common weakness. Opportunities are to be found in user-centred open

innovation processes, in the creation of Nordic SME-based competence clusters in niche areas, the formation of a common Nordic test market for health applications and complementarities in the Nordic industrial structures. Common Nordic threats are the development of Asian R&D competencies, lack of new business models and concepts, and lack of global and visionary views in the development of ICTs.

In the **scenario workshop**, four external socio-technical scenarios were created for the Nordic level. Scenario 1, *ICT for Security's Sake*, describes a very security-driven development of ICTs. Scenario 2, *Nordic Mystique*, emphasises a harmonic open source and SME-based development in a Nordic welfare-driven society. Scenario 3, *Elite User's Paradise*, portrays a globally fragmented and class-divided society of elite users, common users and ICT dropouts. Scenario 4, *Big Business Lock-In*, depicts an ICT future dominated by big players.

In the **roadmapping workshop**, visionary socio-technical roadmaps were constructed in the Nordic ICT Foresight themes. In experience economy, the roadmap topics were automatic language translation and intelligent fabrics and paper. In health the roadmap topic was intelligent systems for self-care, diagnosis and monitoring. In production economy the roadmap topic was a control system for environmentally sustainable and efficient energy use. In security the roadmap topics were a secure management system for energy and a personal traffic agent for security. In addition to these thematic and application-oriented roadmaps, Nordic level summary roadmaps were also formed.

In the **action workshop** the scenarios were further elaborated in the delta analysis. The analysis clarified the outcomes of the scenarios for the Nordic ICT Foresight themes. The action workshop also drafted Nordic level action proposals for each them, which were utilised in the creation of the policy recommendations.

Some **policy recommendations** were formulated on the basis of the research process. The policy recommendations were divided into implementation strategies, i.e. actions that should be proactively pushed through on the Nordic level, and adaptive strategies, i.e. actions that are more reactive in the face of global developments. The *implementation strategies* were 1) creation of Nordic SME-based competence clusters and/or platforms in converging technological

niches, 2) enhancing the utilisation of mobile ICT infrastructures for remote monitoring, 3) an initiative for the creation and integration of Nordic test markets for ICT applications and ICT policies in the health sector, 4) a Nordic level research and policy initiative to develop new ICT-based concepts for information and general security, 5) the ideation and creation of new business models for the user-driven application developments, and 6) a Nordic initiative to enhance electronic business transactions and applications. The formulated *adaptive strategies* were 1) towards a deeper understanding of the cultural contexts of new services and solutions, 2) learning to utilise and productise innovations in the second or third wave, 3) widen the scope of innovation and learn to "recycle" the ideas into new niches, and 4) creating strategies for the utilisation of a "long tail" in the Nordic sphere.

11. Project evaluation

This final chapter considers the project evaluation. The main data for the evaluation is gathered via questionnaires filled in by the participants to the three international workshops the scenario workshop, roadmapping workshop and action workshop. In addition, the project evaluation includes some subjective views of the researchers in the Nordic ICT Foresight core group. It should be noticed that this chapter presents an evaluation summary and therefore does not include any statistics or figures made from the questionnaire data.

A useful framework for analysing foresight processes and the dynamics of shared knowledge creation is provided by the SECI model (Nonaka 1994, Nonaka & Takeuchi 1995, Eerola & Joergensen 2002, 2007). In the SECI model, shared knowledge creation is envisaged as a spiral process in which tacit and explicit knowledge, as well as the different modes of knowledge conversion – i.e. socialisation, externalisation, combination and internalisation – play a central role. The spiral nature of shared knowledge creation means a process that builds on knowledge created during the previous steps and times. Figure 25 shows the SECI model applied to the Nordic ICT Foresight process. For each knowledge conversion mode, the figure also lists the tools and practices of the Nordic ICT Foresight (Figure 25).

According to the SECI framework, our knowledge of future technological developments is a result of a dynamic interaction process where facts, well-grounded views, opinions and tacit knowledge play an important role. Externalisation of tacit knowledge can be facilitated with the help of purposefully assisted dialogues and formal procedures (block of “externalisation” in Figure 25). The various pieces of explicit information must also be meaningfully combined and linked together in order to make the resulting messages interesting. Typical tools for this are various types of reports and presentations, including structured summaries of the relevant facts, different types of scenarios, vision formulations, competence maps, roadmaps and action recommendations (“combination block”). Contextual interpretation and ‘learning by doing’ is, however, needed in order to make the messages useful for the participants to the process and a wider circle of potential users of the foresight knowledge. It is thus advantageous if the project partners are simultaneously involved in relevant

R&D activities and/or strategy work ("internalisation block"). Involvement in a foresight project – as a project partner/steering group member/participant of interactive foresight workshops and/or net-based discussions – provides, in turn, a proper social forum for reflection and cultivation of knowledge among those sharing overlapping and complementary interests and competencies ("socialisation block").

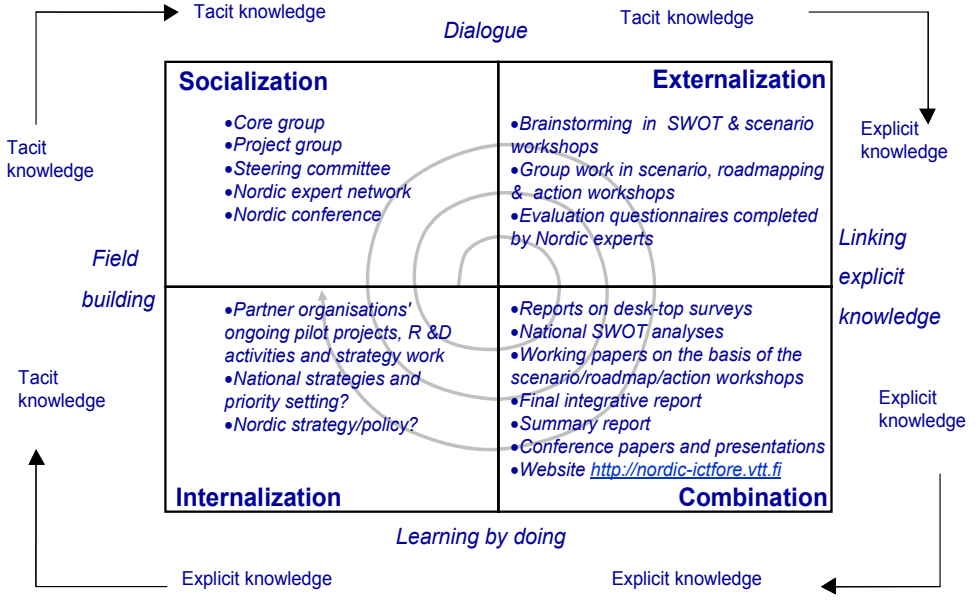


Figure 25. Nordic ICT Foresight within the SECI framework.

In the following we present the general evaluations of the research phases and reflect the phases against the SECI framework in Figure 25. The first phase, the *desktop study*, aimed at defining the boundaries of the technological field through mapping the selected literature. The phase formed a background for the participatory phases. The phase was completed as a research phase with interactive commenting by the core group. Therefore, the phase can be positioned in the socialisation block of the SECI model.

The workshop phase of the Nordic ICT Foresight started with national *SWOT analyses*. The aim of the SWOT analyses was to identify and characterise the main differences in the ICT developments. Analyses were separately executed in all of the project countries (Denmark, Finland, Norway, Sweden) in December

2005 and January 2006. The SWOT workshops were about creating tacit knowledge by defining the characteristics of the target countries, but it was also much about externalising the tacit knowledge into explicit knowledge. Thus the SWOT workshops can be positioned on the borderline between the socialisation and externalisation blocks of the SECI model.

The second workshop, *the scenario and vision workshop*, was carried out in Bålsta, Sweden, in February 2006. The workshop was organised by FOI and emphasised two themes: production of visions of the ICT applications relevant in the Nordic setting and construction of a draft set of external scenarios for the socio-technical environment of ICTs in the Nordic region. The workshop applied the Shell scenario method. The workshop was about externalising research knowledge and internalising expert knowledge. It was about combining explicit knowledge in a dynamic dialogue; therefore it was about externalisation of the knowledge. In addition, the workshop process was evaluated by the participants. In general, the workshop got good ratings and the participants found the workshop process and topics interesting. The workshop process was quite systematic and there were also comments about the tightness of the schedules. But, all in all, the evaluation was very positive.

The third workshop, the *roadmapping workshop*, was organised in Espoo, Finland, in May 2006. The roadmapping workshop formed a process that combined the ideas produced in the workshop with the results of the scenario workshop and SWOT workshops. All the produced material was then elaborated into roadmaps. The roadmaps were made in all the thematic areas of the project (experience economy, health, production economy, security). The scenario workshop and roadmapping workshop were combined in that all the roadmaps were made within the context of the different scenarios. This workshop can be positioned in the externalisation block of the SECI model. However, the workshop had the idea of the linking the knowledge gathered in the scenario workshop with the knowledge collected in the roadmapping workshop. Hence the roadmapping workshop could be positioned on the border between the externalisation and combination blocks in the SECI model. This workshop process was also evaluated by the participants. The general tone of the evaluations was positive and the participants found the process and discussions interesting and challenging. There were, however, some comments about the tightness of the process. This seemed to create a space that did not allow too

much spontaneous dialogue. The changes in the participant structure also complicated the process because the knowledge flow was somewhat disrupted. The general tone of the evaluation was positive.

The fourth workshop, the *action workshop*, was organised by SINTEF in Norway in November 2007. In this workshop the results of the previous workshops were set as a background in order to create action proposals. The action proposals were also made within the context of the Nordic ICT Foresight scenarios. This phase was about the externalisation of the knowledge and combining different views to generate Nordic level action proposals. This workshop was evaluated by the participants. When the chain of the workshops progressed in Nordic ICT Foresight, the process got more and more complicated since the knowledge was gathered on top of the already produced knowledge and within the framework of the formulated Nordic ICT Foresight scenarios. This accumulation of knowledge complicated the process, as did the changing workshop participants. It seemed that the most positive evaluations came from the participants who had been engaging in the whole Nordic ICT Foresight process and not just one workshop. Furthermore, in both the roadmapping workshop and action workshop the scenario context proved to be a quite challenging task. Working in the the scenario mode produced some very interesting and new results in the roadmapping and action workshops, but it also made the process much more complex for the participants. Despite the challenges, the general flavour of the evaluations was a positive one.

It should be mentioned that the internalisation block of the SECI model was already "activated" in the workshop phases since the participants were mainly representatives of the organisations that were active in the Nordic ICT field and foresight. The results of the Nordic ICT Foresight are published in the two reports: the systematic research report published in the VTT series and the Nordic summary report published in the Nordic Innovation Centre's series. These official reports, as well as the working papers published on the website, fulfil the combination block of the SECI model.

In the Nordic ICT Foresight, the following impacts and/or influence paths can are identified:

- The foresight project contributed to the project partners' R&D activities and strategic intelligence.
- Participation in the foresight project extended the project partners' networks and directed interest areas.
- The foresight workshops provided an opportunity to reflect on own ideas in a relatively safe discussion forum.
- The foresight workshops provided an arena to test different foresight methodologies.
- The project allowed the core partners to experiment with combining different methods.
- The foresight project contributed to shared understandings among the key Nordic actors.
- The foresight workshops produced visions of ICTs in the Nordic area and created strategic knowledge about ICTs in the Nordic region.

The overall research process in the Nordic ICT Foresight was carefully planned and thought out. The methods were chained in a fashion that enabled the continual evolution of the project results. However, the methodological framework as such was challenging because the topic and scope of the study was so wide – in some sense the ICTs could cover almost any form of societal interaction in modern society. Therefore, it can be stated that the methods decided on at the start of Nordic ICT Foresight are very suitable for the research focused on some more easily pre-defined topics, such as "the future of oil" or "the future of the car". But in the case of the large and hybrid societal questions, such as ICT applications in society, the looser methods, like SWOTs, need critical focusing to be effective. Therefore, other more societally-oriented methodological frameworks, such as tools of technology assessment or SECI model, could be utilised as a basis for this study. Despite this methodological notion, the research questions in Nordic ICT Foresight were formulated in such a way that the general "looseness" of the methods could be phased out or even turned and used to advance the project.

12. Acknowledgements

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Appendix A: Participants in the workshops

Emerging technologies and SWOT workshop

Ahlqvist, Toni	VTT
Eerola, Annele	VTT
Hamilo, Marja	Technology Industries of Finland
Heinonen, Sirkka	VTT
Kangas, Sonja	VTT
Kivisaari, Sirkku	VTT
Laarni, Jari	VTT
Naumanen, Mika	VTT
Nykänen, Esa	VTT
Pentikäinen, Heikki	VTT
Piira, Kalevi	VTT
Pirttimäki, Antti	VTT
Ruotsalainen, Pekka	Stakes
Siivonen, Timo	VTT
Siltanen, Pekka	VTT
Tommila, Teemu	VTT
Virta, Jouko	VTT

Phase II: Scenario workshop

Ahlqvist, Toni	VTT
Andvig, Björn	SINTEF
Carlsen, Henrik	FOI
Dietz, Jan	The Research Council of Norway
Eerola, Annele	VTT
Eriksson, E. Anders	FOI
Gaard, Jóannes J.	Ingeniørforeningen i Danmark
Gretland, Pål	Norges Närings- och handelsdepartement
Iversen, Jonas Svava	DTI
Kangas, Sonja	VTT
Kristiansen, Ernst	SINTEF
Lewerentz, Birgitta	FOI
Penttilä, Matti	VTT
Pirttimäki, Antti	VTT
Salmi, Pekka	Sitra Industry Ventures, Finland
Sandgren, Patrik	Vinnova – Swedish Agency for Innovation Systems
Vefall, Svein	LO, Norge
Wikland, Joakim	The Sahlgrenska Academy at Göteborg University
Ellingsen, Kristin Woje	SIVA – Selskapet for industrivekst, Norge

Phase III: Roadmapping workshop

Aapio, Toni	Elcoteq
Ahlqvist, Toni	VTT
Andvig, Bjørn	SINTEF
Barck-Holst, Svante	FOI – Swedish Defence Research Agency
Carlsen, Henrik	FOI – Swedish Defence Research Agency
Dietz, Jan	Norges forskningsråd
Eerola, Annele	VTT
Eklund, Pentti	VTT
Ellingsen, Kristin	Siva
Haglund, Henry	Haglund Networks Oy
Hamilo, Marja	Teknologiateollisuus
Heinonen, Sirkka	VTT
Kangas, Sonja	VTT
Kristiansen, Ernst H.	SINTEF
Lewerentz, Birgitta	FOI – Swedish Defence Research Agency
Lillekjedlie, Björn	Forskningsparken AS
Nurmela, Juha	Tilastokeskus
Penttilä, Matti	VTT
Saarikoski, Ville	TIEKE
Salmi, Pekka	Sitra
Sandgren, Patrik	Vinnova
Simons, Magnus	VTT
Vefall, Svein	LO
Westvik, Rita	SINTEF

Phase IV: Action workshop

Ahlqvist, Toni	VTT
Andvig, Björn	SINTEF
Bendixen, Ole Christian	SINTEF ICT
Carlsen, Henrik	FOI – Swedish Defence Research Agency
Dietz, Jan	Forskningsrådet, The Research Council of Norway
Ellingsen, Kristin Woje	SIVA – Selskapet for industrivekst, Norge
Foshaug, Rune	Abelia
Gretland, Pål	Nærings- og handelsdepartementet
Hamilo, Marja	Technology Industries of Finland
Häyrynen, Annakaisa	Elisa Corporation
Kangas, Sonja	VTT Technical Research Centre of Finland
Jensen, Louise Hvid	DTI Danish Technological Institute
Jenssen, Stefanie	Senter for teknologi, innovasjon og kultur
Kristiansen, Ernst	SINTEF
Lewerentz, Birgitta	FOI – Swedish Defence Research Agency
Nilsson, Alexander	VINNOVA
Penttilä, Matti	VTT Technical Research Centre of Finland
Pirttimäki, Antti	VTT Technical Research Centre of Finland
Salmi, Pekka	Sitra Industry Ventures, Finland
Vefall, Svein	Business and Industry Policy Department, LO, Norway
Øvstedal, Eldfrid	SINTEF ICT

Appendix B: Materials of the desktop study

Denmark

1) *Technological Foresight on Pervasive Computing* (2003), Danish Ministry of Science, Technology and Innovation.
2) *Technological Foresight on Cognition and Robotics* (2005), Danish Ministry of Science, Technology and Innovation.
3) *Technological Foresight on ICT – Farm to Table* (2005), Danish Ministry of Science, Technology and Innovation.
4) *Technological Foresight on Bio- and Healthcare technologies* (2003), Danish Ministry of Science, Technology and Innovation.
5) *Future of Healthcare* (2002), paper prepared for the Danish Ministry of Science, Technology and Innovation.
6) *National IT-Strategy of the healthcare system 2003–2007* (2003), Ministry of the Interior and Health.
7) *The role of ICT in the experience economy* (2005), Rambøll Management, for the Danish Ministry of Science, Technology and Innovation.
8) *National growth strategy of information and communication technology (ICT)* (2005), Working paper of ICT-Forum.
9) *IT and Telecom 2005* (2005), Danish Government.
10) *Denmark should win on creativity: Perspectives on the Danish research and education system* (2005), Working Group of the experience economy, Report for Danish Ministry of Science, Technology and Innovation.
11) *Focus on the future. Information and communication technology – result of a dialogue* (2004), Danish Government.
12) *Denmark in the culture and experience economy – 5 new ways* (2003), Danish Government.
13) *Danish Research and business in relation to cognition and robotics* (2005), Work report from the Technological Foresight on Cognition and Robotics, Danish Ministry of Science, Technology and Innovation.
14) *Business visions and strengths in relation to innovation in robotics* (2005), Work report from the Technological Foresight on Cognition and Robotics, Danish Ministry of Science, Technology and Innovation.
15) *Explorative interviews with users – visions in relation to innovation in robotics* (2005), Work report from the Technological Foresight on Cognition and Robotics, Danish Ministry of Science, Technology and Innovation.
16) *Businesses – visions in relation to innovation in robotics* (2005), Work report from the Technological Foresight on Cognition and Robotics, Danish Ministry of Science, Technology and Innovation.
17) *IT with considerations, Work programme for IT and telecom* (2003), Danish Government.

18) *IT on the right place and time* (2004), Danish Ministry of Science, Technology and Innovation.
19) *Public research and development in healthcare informatics – status 2004* (2004), Aalborg University.

Finland

1) *Trust in the New Economy – The case of Finnish Banks* (2004), Ministry of Transport and Communications.
2) *Security Technologies in Home and Wireless Networking Environments* (2004), VTT.
3) *Process Approach to Information Security Metrics in Finnish Industry and State Institutions* (2004), VTT.
4) *Secure Auctions for Mobile Agents* (2004), VTT.
5) *Mobilizing Business Applications* (2005), Tekes.
6) *Information Technologies for Value Network Integration* (2002), VTT.
7) *Pharma Development in Finland Today and 2015* (2004), Tekes.
8) *Ubisoft – Pervasive Software* (2004), VTT.
9) *Roadmap for Technologies and Services* (2004), Tekes.
10) *Next Generation of Industrial Automation* (2005), VTT.
11) *Technology Watch Report* (2002), Senior Watch.
12) *Nets – Networks of the Future* (2005), Tekes.
13) *Older People and Information Society Technology* (2002), Senior Watch.
14) *Research view of Finnish automation industry* (2004), VTT.
15) *Creating a Safer Information Society* (2004), Ministry of Transport and Communications.
16) *User-acceptance of mobile services* (2005), VTT.
17) *User acceptance of location-aware mobile guides based on seven field studies* (2005), E. Kaasinen in Behaviour & Information Technology, Vol. 24, No. 1, pp. 37–49.
18) *Context-aware Services for Mobile Users* (2004), VTT.
19) *Communication Technologies – VTT Roadmap* (2002), VTT.

Sweden

1) *New, Better and More Secure – IT in the Service of Future Society* (2004), B. Dahlbom & U. Brandén et al.
2) *The Production System – Engine of Swedish Prosperity* (2004), B. Lindnjerg & J. Fagerström et al.
3) *Materials and Material Flows – Challenges and opportunities* (2004), G. Jönsson & K. Leander et al.
4) *Infrastructure for a Borderless Europe* (2004), B. Wijkmark & J. Parmeby et al.
5) *Biological Natural resources – A Swedish Strength for the Future*, S. Normark & A. Sandström.

6) *The Health Care of the Future – Advances and Challenges* (2004), S. Normark & A. Sandström et al.

7) *Education and Learning* (2004), B. Svensson.

8) *Inspiration for Innovation – Knowledge and Technology Looking Toward 2020* (2004), T. Thorvaldsson & T. Malmer et al.

9) *Other National Foresights* (2004), L. Elg.

10) *The Context of Technology* (2004), J. Palme & J. Edling et al.

11) *Choosing Strategies for Sweden* (2004), J. Nygren et al.

12) Hälso- och sjukvården til 2030 (2005), Ackerby et al., Sveriges Kommuner og Landsting.

13) Kvarboende och äldrevård i hemmet med moderne teknik, A. Essen & A. Hrdlicka, Institut for framtidsstudier.

14) Roadmap Wireless systems 2005 to 2010 (2005), B. Karlson, O. Mäkitalo, M. Nilson & J. Zander, Royal Institute of Technology.

Norway

1) Eerola, A. & Holst-Jørgensen, B. (2002). *Technology foresight in the Nordic countries*, http://www.risoe.dk/rispubl/sys/syspdf/ris-r-1362.pdf (23rd of January 2006).

2) Hygen, J. (2005). *Health Informatics and Telemedicine in Norway*, http://www.kith.no/upload/1751/NSTanniversary.pdf (20th of January 2006).

3) OECD (2003). *Seizing the benefits of ICT in a digital Economy*, (23rd of January 2006).

4) OECD (2004). *ICT diffusion to business: Peer review country report*, Norway, http://www.oecd.org/dataoecd/32/7/34228124.pdf (23rd of January 2006).

5) *Medicine and Health 2020 (Medisin og Helse 2020)* (2000). The Research Council of Norway.

6) *The Norwegian Board of Technology's scenario workshop on elderly people and ICT in health care services (Teknologirådets scenarieverksted om Eldre og omsorgsteknologi)* (2000). The Norwegian Board of Technology.

7) *Elektronisk samarbeid i helse- og sosialsektoren* (2004). The Ministry of Health Services and the Ministry of Social Affairs.

8) *e-Norway. e-Norge* (2004). Tilstandsrapport 2004. The Ministry of Trade and Industry.

Appendix C: Visions and drivers produced in the scenario workshop

Visions – brainstorming

The first brainstorming session aimed at a broad collection of participants' ideas on visions for the "adoption of ICT for increased productivity and enhancement of social well-being". Below, the results are sorted according to the four focus areas of the project. They are presented in no particular order.

Experience Economy

- Flexible channels to involve citizens in digital media
- ICT products without batteries
- Personal area networks – media entertainment wherever you go
- Nordic countries leading in context sensitivity services; marketing, games, tourism
- ICT in support of foresight: new ways of visualising possible futures through games, simulations, etc.
- "Smart dust" – temporary networks/devices
- Support to flesh and virtual communities
- Intelligent paper, images, videos, sound
- Smart jogging tracks; mobile virtual coach, exergames to motivate
- Products from E.E. used in education
- Convergence Nordic design and ICT
- Online sports measurements, i.e. golf, football, ski, etc.
- Augmented, intelligent solutions -> virtual objects and holograms in real environments, travelling, games
- Multisensory learning environments
- Simultaneous translation and conversation between written and spoken text

Health

- A single Nordic demand side for ICT in the health sector
- ICT for de-medicalisation
- Utilising Nordic ICT solutions on global health programs
- ICT in the education sector as support to less capable individuals
- Homecare by smart computers guides connected to your medical journal
- Nordic countries strong on bio-sensors and integration to ICT systems
- Homecare ICT applications that support meaningful human interaction and care (without stealing the attention to the ICT applications themselves)
- Personal fitness monitoring systems
- ICT used to enhance learning and implementation of complete ICT systems
- Nordic countries leading in reconstructing home-hospital balance
- Personal health data card – drivers in IT security
- One journal (EHR) accessible everywhere
- Small detectors to detect illness (e.g. flu)

Production Economy

- Smart RFID tags following goods and food
- A transport system that brings cars on rails at a fast speed (Sthlm-Gbg-Oslo)

- ICT for oil and gas production in Arctic areas
- Broadening the concepts of Internet café to a "workplace-where-and-when-you-want" concept
- Self-monitoring devices in production -> informs the operator that "n and n" will break
- Smart production via use of sensors
- ICT systems to manage resources and processes in hospitals – tracking patients, doctors; treatment programs; actively steering
- ICT tools to improve co-operation by/with regions (for SMEs)
- Markets, competencies, funding
- Local production plants – CAD/CAM -> ICT to own design
- Human-free automated car factories

Security and Safety

- Nordic balance between integrity and security creates new business opportunities
- Secure Internet via incentives to users (club for careful)
- Trust generators and fosterers
- Distributed data storage -> really important information in different places to non-important
- Services for dummies
- Intelligent automatic visual surveillance in public places
- RFID killer – privacy protection for consumers
- Nanoscale crime implants – track criminals worldwide
- Augmented reality "invisible"/integrated glasses for security personnel – instructions
- Neighbourhood security solutions with seamless ICT infrastructure
- "Electronic passport" to enable e-democracy in Europe

General

- Nanoelectronics -> non-heating devices, very fast devices, flexible devices
- 100% recyclable, low-energy ICT devices using renewable energy
- Embedded systems with AI improve performance, with opt-out option; privacy at home
- Environment surveillance – public health monitoring
- Nordic cooperation to develop global governance
- Smart ICT solutions radically reduce energy demand
- Real-time shoring between local authorities e.g. environmental
- 2012 peak oil: ICT to dematerialise production, immaterialise consumption
- ICT used to create virtual organisations – "same goals"
- Body area networks
- Foldable (very small) mobile communication and deployable devices
- Batteries (fuel cells) that must be loaded only once in six months or one year
- E-government
- Wearable computing adapting to temperature, etc.
- Ecological "balanced scorecard" on all regional natural resources
- "Invisible" noiseless (non-humming) wireless ICT applications (also wireless connection to power sources)
- User interface must be simple
- Hidden technology (speech recognition)
- Feed-back loops in car systems reduce fuel consumption and traffic jams
- For aquaculture: identify illness among fish (river, sea, fish farming) with sensors/microchips
- Intelligent fibre-based materials
- Packing (e.g. anti-tamper), integrated publishing

Drivers: Brainstorming and priority setting

This session was the kick-off for the scenario work. The idea was to set the scene for possible future introduction of ICT solutions in the Nordic countries. This was achieved via a set of *external* scenarios, i.e. external with regard to… As a first step in the development of the scenario set, the brainstorming focused on the collection of drivers. The focus was set on *drivers* for the future socio-technical environment that may act as substantial barriers or carriers for the *adoption* of selected ICT solutions. All drivers were then grouped into 41 clusters and each was given a name.

In the next session, "priority setting", the participants voted according to the degree of *importance* and *uncertainty*. Each individual had twelve green votes for importance and twelve red votes for uncertainty to distribute among the clusters. More precisely, red votes are interpreted as uncertain *and important*. The most relevant measure of importance, therefore, is the sum of red and green votes.

Below follows all the drivers grouped according to the clustering. The total number of votes is given for each cluster.

1. *Corporate social responsibility* (2 green, 6 red)
   CSR with respect to misuse-prone Internet services
   Corporate social responsibility
   New management paradigms -> e.g. decline of neo-liberalism, resurgence of rigid planning

2. *Changing labour market* (8 green, 4 red)
   Personal insecurity
   Project employment vs. full-time, long-term employment
   Unemployment in Western world
   Fewer people in the workforce

3. *US/Global economy* (9 red)
   US economy collapses?
   Stable economy
   State deficit brings US economy to its knees. China takes over

4. *Challenges to SMEs in global economy* (2 green)
   SCM → Increased requirements on suppliers
   Centralised public procurement
   Consistent framework conditions for SME export

5. *New ICT-related health risks* (7 green, 13 red)
   Health risks in ICT use
   Evidence of ICT health risks

6. *IPR* (4 green, 8 red)
   One-stop-shop for worldwide patents (IPR)
   IPR (Patents) Global
   Open source development
   IPR with regard to climate change innovation

7. *ICT Trust* (11 green, 6 red)
   Need for robust global communications in crises
   Secure Internet
   Robust global communications/mobile
   Need for security

8. *Free services* (8 green, 4 red)
   Skype-like services
   Fast, easy & cheap access to social service
   Ad-hoc free-of-charge networks
   New economy in scale-free networks

9. *Mass customisation* (10 green, 7 red)
   Customisation/personalisation at low cost
   Culturally adaptable ICT via modularisation
   AI in home appliances – a way to personalise

10. *User-centred applications development* (10 green)
    New media
    – Virtual reality
    – Context-aware applications
    Easy-to-use ways to overcome information overload
    Development of living labs to involve end users – a Nordic model?

11. *Ageing population* (11 green)
    Ageing population
    Expensive cures for diseases
    Ageing rich
    Generation gap

12. *Trust* (4 green, 2 red)
    End of trust
    Corruption

13. *Shortage of basic resources* (3 green, 6 red)
    Global shortage of clean water
    Rising prices for raw materials
    Lack of energy resources
    Russian gas blockade

14. *European ICT R&D policy* (1 green, 8 red)
    Political will to utilise information society programmes
    Europe tries to deliver on Lisbon
    Europe tries to compete with US

15. *Challenges to SMEs in global innovation system* (3 green, 1 red)
    Will there be (strong) Nordic players in generic technologies?
    Number of available technology options explodes
    (Business) Applications become more systemic
    Who will lead the adoption?
    One player holds smaller piece of the whole

16. *Global R&D market* (12 green, 6 red)
    R&D sourcing of global companies
    Globalisation of R&D workforce
    Countries > specialisation in R&D
    Internationalisation of innovation systems
    Global division of work

17. *Safe food* (5 green, 6 red)
    Requirements for safe food
    Need for "clean" and healthy food – seafood
    Utilisation of the coastal environment

18. *Return of protectionism* (7 red)
    Protectionism & isolation

19. *Urban vs. Rural* (1 green)
    Urbanisation/population clusters in Nordic countries

20. *Nordic social model & values* (9 green, 8 red)
    End of the Nordic model
    New taxation paradigm (no VAT)
    Wish to work less
    Nordic countries cooperate in an organised way, e.g. standards
    Nordic countries attract R&D because they have a tradition of teamwork

21. *Terrorism* (2 green, 10 red)
    Fear of terror
    War and terrorism

22. *Pandemic* (2 green, 6 red)
    Pandemic threats

23. *Organised crime* (3 green, 8 red)
    Organised crime – Internet an arena
    Russian and Baltic mafia dominate Nordic economy
    Piracy

24. *ICT Legislation* (1 green, 2 red)
    Supranational legislation on ICT (EU, NTO)

25. *Climate change* (6 green, 5 red)
    Decrease in rain forests increasing deserts → climate change
    Climate change
    North Pole melts away
    Natural catastrophes (cf. Tsunami)

26. *States run as corporations* (1 red)
    States are coordinated more and more like enterprises → competition between States

27. *Mass migration* (1 green)
    A country collapses, like New Orleans
    Mass migration to Europe from Africa

28. *New professions* (3 green)
    Possible new professions→ e.g. bioelectronic designer, weak signal catcher, technology interface adviser

29. *Educational incentives* (10 green, 2 red)
    Education system – lack of specialists
    Lack of technology and science interest among the young

30. *New power solutions* (5 green, 1 red)
    New, lighter and more efficient batteries for mobile technologies
    Electric cars become common

31. *E-Government* (2 red)
    Transparent e-democracy (Nordic countries)
    New democracy in scale-free networks

32. *Digital divide* (6 green, 7 red)
    Cultural fragmentation – generations – subcultures
    Gender gap
    Media literacy – ability to use technology, to keep up with developments

33. *Asia rising* (13 green, 5 red)
    Asian middle class > 1 bn
    Language barriers
    Mandarin and Hindi requirements for manufacturing
    Rising wages in China → more ICT

34. *Requirements for flexibility* (0)
    Volatility increases in terms of everything

35. *Space developments* (2 red)
    Development of space travelling
    Will there be a new age of space exploration? Colonise Mars?

36. *Technomania* (7 green, 4 red)
    "New is always better"
    Entertainment non-stop
    Bandwagon, me too effect
    Moore's law and more than Moore

37. *ICT Techno opt-out* (6 green, 3 red)
    ICT opt-outs
    Big brother not accepted

38. *Acceptance of new technologies – bio, nano* (2 green, 12 red)
    Public acceptance or opposition to n-tech – too-uncertain consequences
    Genetic "deconstructions" – GM Food – GM Cures
    Rapid changes in moral climate – e.g. biotech

39. *Strong basic values* (8 green, 11 red)
    Muslim groups to restrict Internet
    Global religious movements
    New global political parties vs. polarisation US/West–rest
    Freedom and independence as increasing basic values – indiv. cev.

40. New global e-communities (3 green, 4 red)
Global, virtual clans → e.g. "doom players", "Soap opera enthusiasts"
Increase of virtual organisations

41. Global tech lock-ins (2 green, 6 red)
Global monopolies, lock-in technological development
Microsoft and Google de facto standard

Back-office work during the evening of February 9

A further clustering was done with the results from the voting above. The total number of votes and the sum of the red votes are given after each new "super cluster" name.

Other technologies (8 total, 3 red)

30. New power solutions
35. Space development

ICT-related values and trends (56 total, 30 red)

36. Technomania
32. Digital divide
37. ICT techno opt-out
5. New ICT rel. health risks
26. States run as corporations
31. E-Govt
34. Reqts for flexibility

ICT-related innovation systems (73 total, 31 red)

6. IPR
14. European ICT RDT policy
2. CH. labour mkt
28. New professions
15. Challenges to SMEs
24. ICT legislation
16. Glob R&D market
29. Educational incentives

ICT-related emergent phenomena (71 total, 27 red)

8. Free services
9. Mass customisation
41. Global tech lock-ins
10. User-centred application development
40. New global e-Communities
7. ICT Trust

General values & trends (62 total, 27 red)

39. Strong basic values
20. Nordic soc. model & values
1. Corporate social responsibility
12. Trust
11. Ageing population
19. Urban vs. rural

Global economy (36 total, 21 red*)*

3. US/global economy
33. Asia rising
18. Return to protectionism
4. Challenges to SME/Glob economy

ICT external threats (77 total, 53 red)

21. Terrorism
23. Org. crime
17. Safe food
22. Pandemic
38. Acceptance of new technologies – bio nanotech
13. Shortage of basil res.
27. Mass migration
25. Climate change

These seven super clusters constituted the shortlist for dimensions in the scenario set. A set of four scenarios, hence two dimensions, was the working hypothesis of this work. However, the working group found three dimensions particularly interesting. The three dimensions and their proposed names were:

- user acceptance (*ICT-related values and trends*)
- business paradigm (*ICT-related emergent phenomena* and *ICT-related innovation systems*)
- major value shift (*general values & trends* and *ICT external threats*).

Appendix D: Visions produced in the roadmapping workshop

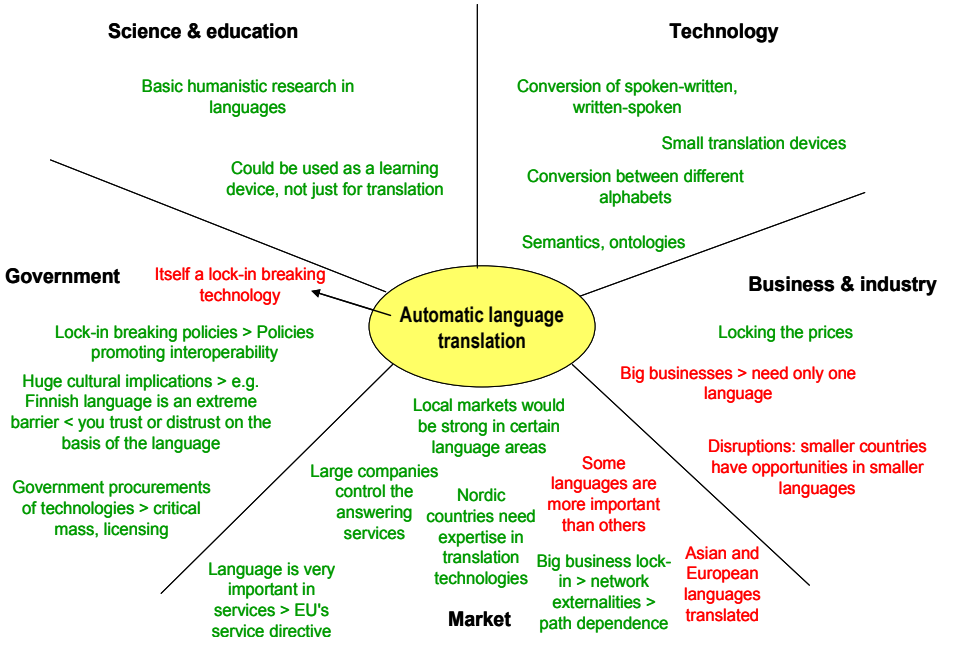
Experience economy (Big Business Lock-In scenario)

All visions (number of votes in the prioritisation)

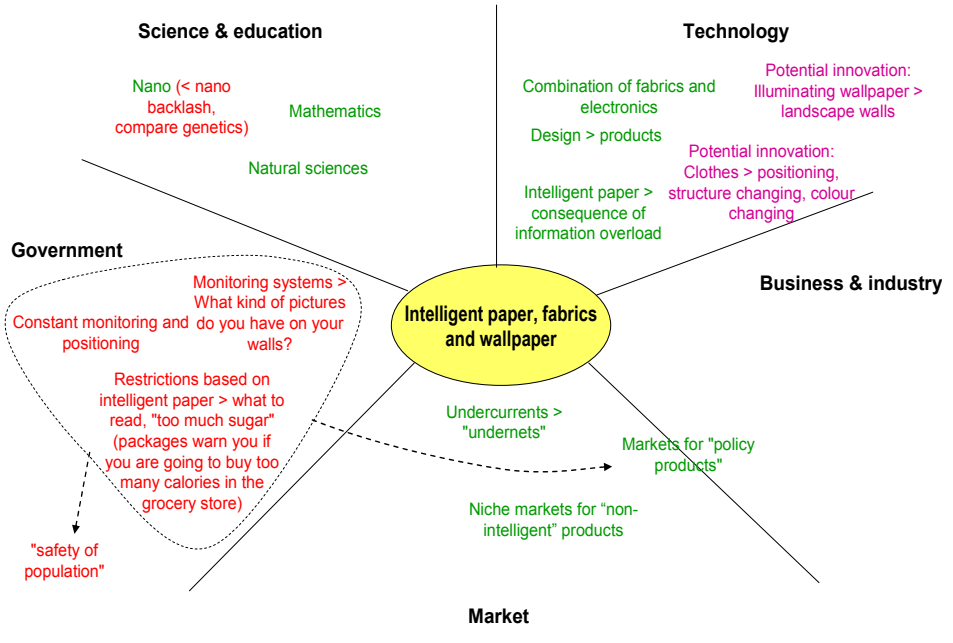
Automatic language translation (10)
Intelligent lenses (8)
Intelligent fabrics (5)
Intelligent wallpaper (5)

Enhanced reality games (5)
Smart wear (5)
ICT for knowledge development (4)
Democracy by voting in locations other than your own (4)
Interactive homes > colour after mood (3)
All sensor sport events (2)
Art on demand (2)
Smart training (2)
Mobile video on demand / bandwidth (2)
A more human and physical Internet (2)
ICT in support of local political process (1)
A personal DJ > mood and context-sensitive (0)
3D visualisation and recording paradigm (0)
Mobile talk on demand (0)
Ambient intelligence (0)
Rich media beyond known implementation (0)

Vision stars: experience economy



Vision star of automatic language translation.



Vision star of intelligent paper, fabrics and wallpaper.

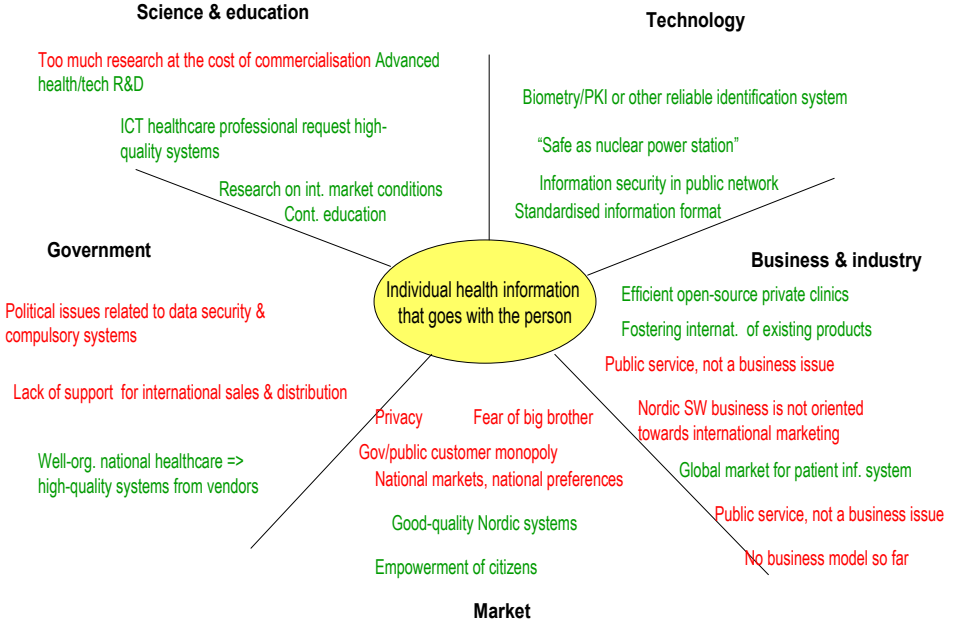
Health (Nordic Mystique Scenario)

All visions (number of votes in the prioritisation)

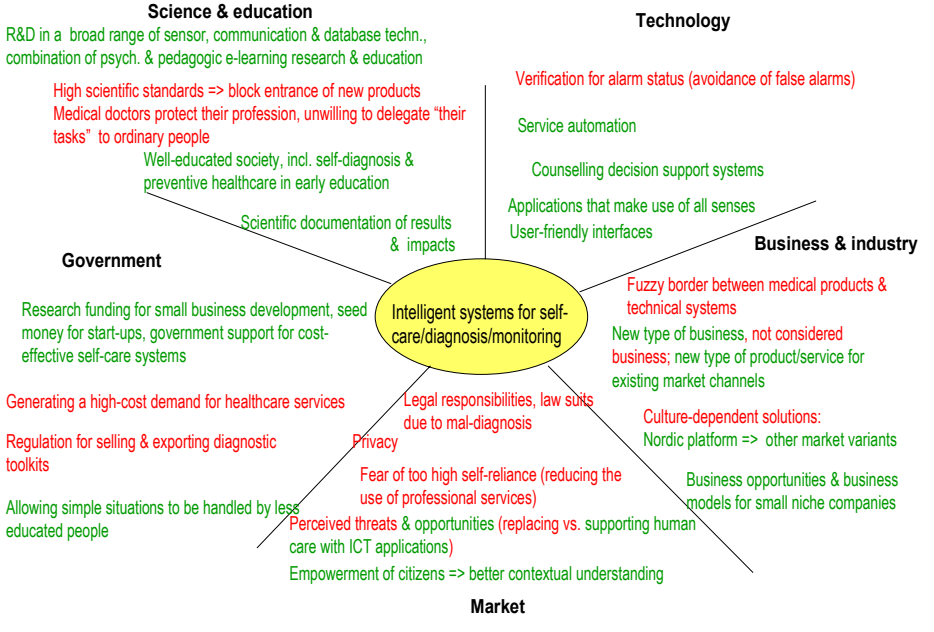
Self-help health system via ICT (11)
The personal healthcard (8)

Integrated Nordic health policies (8)
Networking responsibility system (5)
Biometric tags (4)
Multipurpose card – health is just one application of it (4)
The personal health device (4)
Early warning for elderly at home (3)
Gadget that helps me to get into other people's heads (3)
Multipurpose chip instead of card (2)
Intelligent local systems – interoperability (2)
The "health gate" – just pass and you know (1)
Data storage systems (1)
More professional / action-oriented system (1)
A single Nordic demand for ICT in the health sector (0)
European health journal (0)
Microcameras for e.g. ambulances (0)
Location tracking – falling down, etc. (0)
Monitoring virtual friend (0)

Vision stars: health



Vision star of individual health information.



Vision star of intelligent systems for self-care.

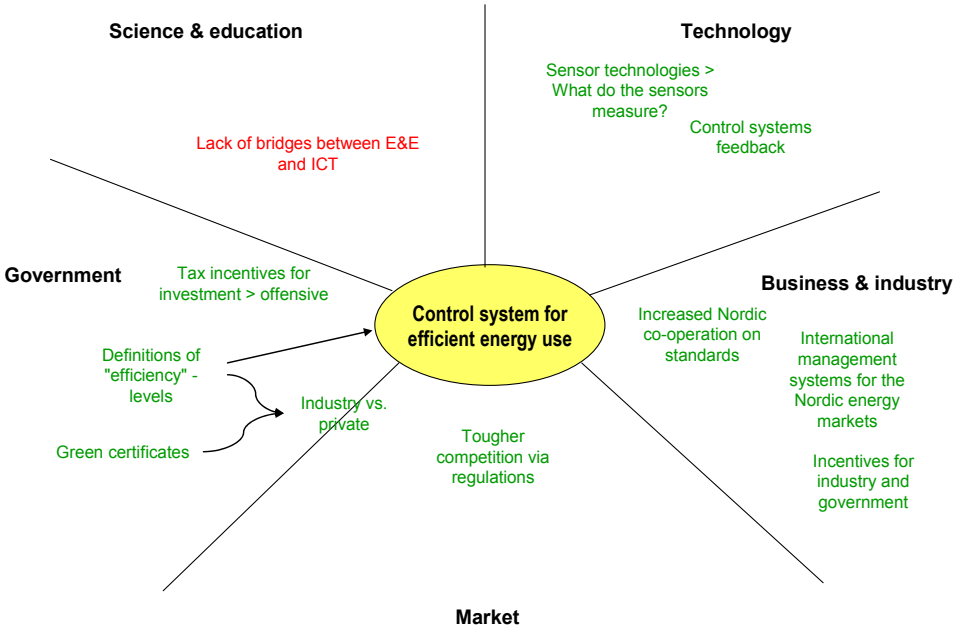
Production economy (Elite User's Paradise scenario)

All visions (number of votes in the prioritization)

Control system for efficient energy use (12)
Digital production / one-click cleaning system (10)
New clean energy without disturbing the environment (9)
Business system for the informal economy (6)

Self-monitoring and robust production lines (5)
Increased Nordic co-operation on standards (2)
Plug'n'play production cell (1)
System that allows personal tailoring (0)
System that allows personal tailoring (0)

Vision stars: production economy



Vision star of control system for efficient energy use.

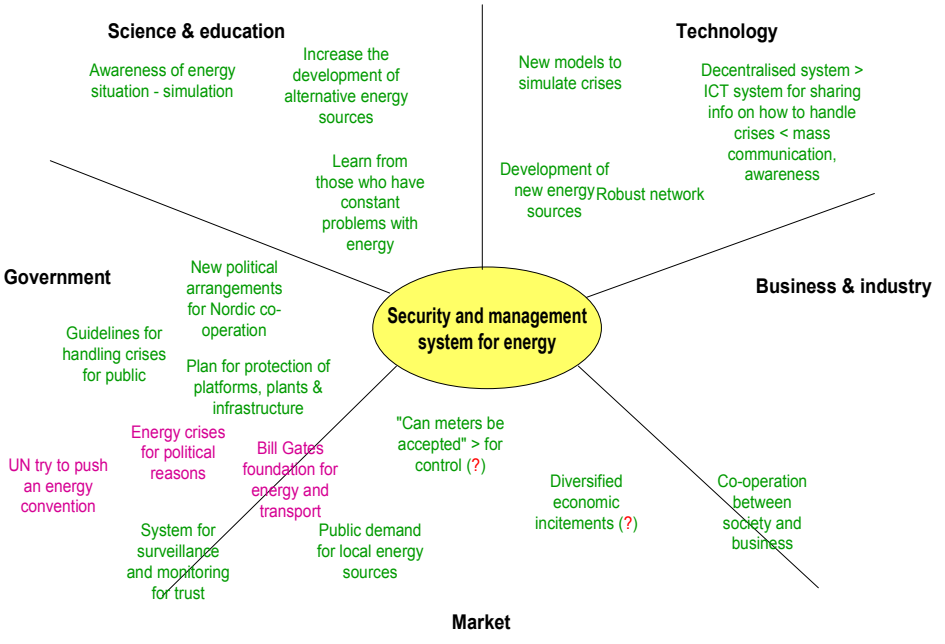
Security (ICT for Security's Sake scenario)

All visions (number of votes in the prioritization)

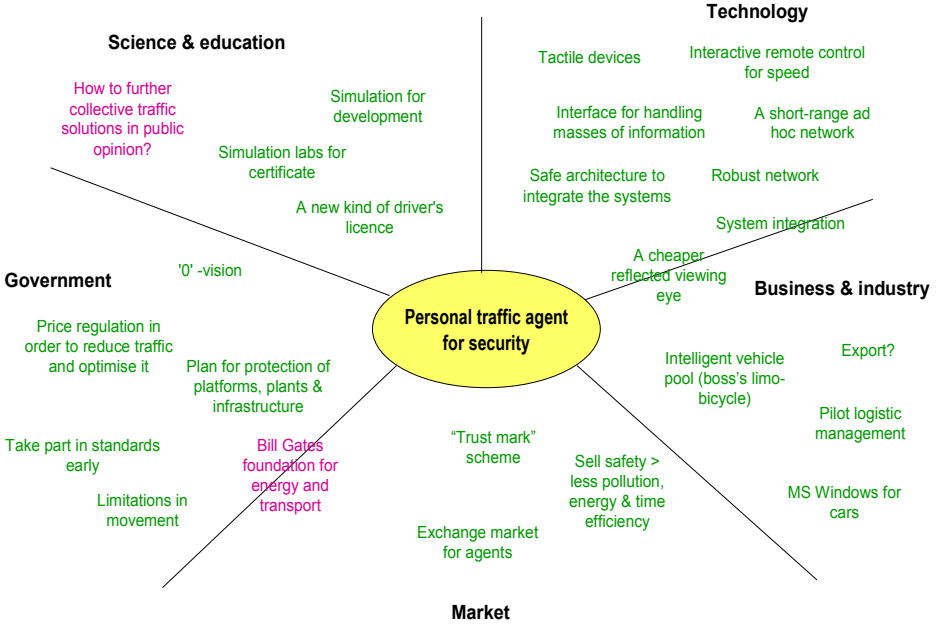
Security and management system for energy (6)
Personal traffic agent for security (6)

Safe food tracing via ICT systems (8)
Intelligent traffic monitoring system (6)
Health monitoring of operators (cars, buses...) (3)
Mobile closed networking (2)
A closed safe Internet (2)
Security system for neighbourhoods (2)
Self-tracking system (2)
Electronic passport – automatic protection (1)
Handling of disruptive events – energy crises (1)
Lost child tracking system (1)
Dangerous goods warning system (0)
Warning system for abnormal driving (0)
Information & booking system for transportation – to reduce traffic (0)
Redirecting traffic (0)
System for regulation (0)
Improving emergency plan (0)
Local autonomy – independent production (0)
New kind of energy sources for new batteries – ICT to reduce energy consumption (0)
New privacy policies for the sensor society (0)
Health monitoring (0)

Vision stars: security



Vision star of security and management system for energy.



Vision star for personal traffic agent for security.

Appendix E: Vision matrices and drafts produced in the action workshop

Draft outcomes of the scenarios

Outcomes of scenario 1: ICT for Security's Sake
Experience economy • Development of ICT is slow because of the restrictions, control and regulatory barriers • The research efforts are directed to the field of security • The security-driven power structure is opposed by local co-operation nets (co-nets), which are based on underground ICT-culture
Health • Total traceability in healthcare – one cannot get medical treatment without being registered and filed • The insurance companies are interested in the medical databases. It might end up in a situation where one cannot get a job without showing a clean health record • Structure of medical provision creates an "underworld", an alternative health sector for people with special needs • Some people go to Asia for anonymous health treatment
Production economy • In some specific industries, as in security and food, the Nordic production is secured via subsidies • Public investments in security and the food industry • Generally protecting and closed culture in the industries
Security • Control of all steps we take. We cannot travel, we cannot shop, we cannot communicate without being traced • New products and services permit digital integrity for those willing to pay. This is illegal, but forces in this direction are strong • Some business communities, e.g. large pharma, don't trust the public digital infrastructure and build their own "co-net" (co-operation nets) • Gated communities are common in the bigger cities in the Nordic countries • Many systems are of critical importance (railways, airports, energy systems, healthcare systems, water supplies) and have their own isolated digital infrastructure • This is a digitally fragmented world • Guarded lakes • Sensor technology is an important research area • Membership of NATO more important than the EU

Outcomes of scenario 2: The Nordic Mystique
• Open source model • Impacts of China and India? • What are the possibilities of the Nordic model still being the incremental innovation model? • Open extreme ICT development (technomania) • Nordic countries export products that combine ICT and welfare and policy ideas (eGovernment, eHealth…) • The key idea is the somewhat equal distribution of welfare, not welfare per se > effective societal system that can distribute welfare • Transparent global village > open source and other elements of the scenario manuscript • We should probably not be too optimistic about the adoption of the Nordic model because of cultural competition (e.g. China, India)

Outcomes of scenario 3: Elite User's Paradise

- Globally fragmented and class-divided society
- Smarthouse, freedom of life for the elite – standardised low-key services for the rest
- Social tensions between the groups, lack of education, lower life expectancy
- Scenario opens up potential for the Nordic region to be the choice of the elite: "look to Scandinavia", business opportunities within niches that cater for specialised solutions
- New solutions developed and implemented in Scandinavia, production takes place in low-cost countries. IPR secures the income
- Special to Scandinavia: energy-efficient solutions, good healthcare, quality of life, Scandinavian design. Healthy economy allows well-paid jobs. Create good job opportunity in different fields

Outcomes of scenario 4: Big Business Lock-In

- ICT application to as many as possible for max profit
- Still a good Nordic test market for ICT, early adaptors, underprivileged groups
- Underprivileged groups could be a market opportunity
- De facto standards in ICT health applications and e-learning
- Patients will communicate with the health authorities online
- Sympathy for underground activity
- All media content available on the Internet but Nordic languages are behind
- Exclusive links between universities and private companies are more accepted

Draft socio-technical visions in Nordic ICT Foresight themes

Experience economy

PLAUSIBLE SOCIO-TECHNICAL VISIONS			
SCENARIO 1: ICT for Security's Sake	**SCENARIO 2: The Nordic Mystique**	**SCENARIO 3: Elite User's Paradise**	**SCENARIO 4: Big Business Lock-In**
Smart training & education > for creating Nordic education systems, combining Nordic universities	Smart training & education > for creating Nordic education systems, combining Nordic universities	Smart training & education > for creating Nordic education systems, combining Nordic universities	Smart training & education > for creating Nordic education systems, combining Nordic universities
Enhanced reality games for the visualisation of threats			
Creation of interactive, virtual electronic spaces	Creation of interactive, virtual electronic spaces	Creation of interactive, virtual electronic spaces	Creation of interactive, virtual electronic spaces
XX electronic spaces	XX electronic spaces	XX electronic spaces	XX electronic spaces

Health

PLAUSIBLE SOCIO-TECHNICAL VISIONS			
SCENARIO 1: ICT for Security's Sake	**SCENARIO 2: The Nordic Mystique**	**SCENARIO 3: Elite User's Paradise**	**SCENARIO 4: Big Business Lock-In**
A single Nordic demand side for ICT in the health sector	"Home medicine", personal healthcare/preventive medicine (provided)	"Home medicine", personal healthcare/preventive medicine (bought)	A single Nordic demand side for ICT in the health sector
Personal Health card	Assisting and socially activating applications (provided)	Assisting and socially activating applications (bought)	
	Early warning system for elderly at home		
Early warning system for elderly at home	ICT used to enable prolonged working life		

SCENARIO 2: The Nordic Mystique				
SOCIO-TECHNICAL VISION "Home medicine", personal healthcare/preventive medicine (provided)				
Action	**Actors**	**Enabling factors**	**Bottlenecks**	**Timing**
1:			User acceptance of system surveillance	
2: Knowledge of and competence in preventive actions	Putting more resources into *society's health* areas on the general levels			

Production economy

PLAUSIBLE SOCIO-TECHNICAL VISIONS **"Barents on screen" is a total surveillance system for all activity in the Barents region. It involves communication systems and eco systems.** **Home automation** **Convergence of information systems** **Need for new ways of management**			
SCENARIO 1: ICT for Security's Sake	**SCENARIO 2: The Nordic Mystique**	**SCENARIO 3: Elite User's Paradise**	**SCENARIO 4: Big Business Lock-In**
Barents on screen	**Need for new ways of management**	**Home automation**	**Convergence of information systems**

Security

SCENARIO 1: ICT for Security's Sake				
SOCIO-TECHNICAL VISION **Co-nets** **This is interesting because we are so digitalised** **A are owned by big companies; B network for the public; in the B-nets we do as good as we can via a logical structure.**				
Action	**Actors**	**Enabling factors**	**Bottlenecks**	**Timing**
	Big companies, big pharma	Security attacks		
		Spam		
		Disrupted Internet		
		Collapsing Internet banks		

PLAUSIBLE SOCIO-TECHNICAL VISIONS/Product goals/examples Co-nets (isolated Internets): The possibility to build secure nets for specific purposes Security and management system for energy Security and management system for water supply Personal traffic agent for security Digital version of the cultural content for small language areas			
SCENARIO 1: ICT for Security's Sake	**SCENARIO 2: The Nordic Mystique**	**SCENARIO 3: Elite User's Paradise**	**SCENARIO 4: Big Business Lock-In**
Co-net (more physical protection)			
	Digitalisation of cultural heritage of small languages		Digitalisation of cultural heritage of small languages
	IT-system or IT usage with kept integrity		
Security and management system for energy		Security and management system for energy	
Personal traffic agent for security	Personal traffic agent for security		

SCENARIO 1: ICT for Security's Sake SOCIO-TECHNICAL VISION Security and management system for energy				
Action	**Actors**	**Enabling factors**	**Bottlenecks**	**Timing**
1:		High energy prices		
2:		Terrorist actions targeted on the energy system		
3:		Tension with Russia and/or conflicts in the Middle East		
4:		Disturbance to the Norwegian oil industry		
5:			Complex problem;	
6.			Many actors involved	
7	Nordic "Kraftbörsen"			
	Big companies			
	Governmental agencies (Svenska kraftnät, Fingrid, Statkraft)			
		Energy crises like 1973 create awareness		

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Author(s)
Ahlqvist, Toni, Carlsen, Henrik, Iversen, Jonas & Kristiansen, Ernst

Title

Nordic ICT Foresight
Futures of the ICT environment and applications on the Nordic level

Abstract

The Nordic ICT Foresight project was launched in May 2005 with research partners VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The aim of the project was to contribute to the strategic intelligence of the Nordic knowledge region so that the full potential of information and communication technology can be exploited to increase the welfare in the Nordic countries. The focal areas of the ICT applications in this study were experience economy, health, production economy and security. In the research process there were five research phases: 1) desktop survey, 2) SWOT analysis, 3) scenario and vision workshop, 4) roadmapping workshop and 5) action workshop. The research phases (3, 4 and 5) were carried out as focused workshops that applied different methods. Publication presents scenarios, roadmaps and action path analyses of the potential developments of ICTs on the Nordic level. Policy recommendations were formulated on the basis of the research process. Policy recommendations were divided into implementation strategies, i.e. actions that should be proactively pushed through on the Nordic level, and adaptive strategies, i.e. actions that are more reactive in the face of global developments.

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Tekijä(t)
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Nimeke

Pohjoismainen IT-ennakointi
IT-ympäristön ja -sovellusten kehityspolkuja Pohjoismaissa

Tiivistelmä

Pohjoismainen projekti "Nordic ICT Foresight" käynnistettiin tutkimusorganisaatioiden VTT (Suomi), FOI (Ruotsi), SINTEF (Tanska) ja DTI (Norja) toimesta toukokuussa 2005. Projektin tavoitteena oli tarkastella informaatioteknologian tulevaisuuksia pohjoismaisista näkökulmista sekä luoda strategioita informaatioteknologian hyödyntämiselle pohjoismaisella tasolla. Tutkimuksen strategisia näkökulmia olivat etenkin IT:n kommunikaatio- ja vuorovaikutussovellukset, terveydenhuollon sovellukset, tuotantosovellukset sekä turvallisuussovellukset. Tutkimusprosessi suoritettiin viidessä vaiheessa: 1) taustaraporttien analyysi, 2) SWOT-analyysi, 3) skenaario- ja visiotyöpaja, 4) tiekarttatyöpaja ja 5) toimenpidetyöpaja. Projektin työpajat sovelsivat erilaisia ennakointi- ja työskentelymenetelmiä. Julkaisussa esitetään skenaarioita, tiekarttoja ja toimenpideanalyysejä informaatioteknologian potentiaalisista kehityskuluista pohjoismaisella tasolla. Tutkimustulosten perusteella muodostettiin politiikkasuosituksia. Politiikkasuositukset jaettiin ns. implementaatiostrategioihin eli toimenpiteisiin, joita tulisi edistää erityisesti pohjoismaisella tasolla, sekä adaptiivisiin strategioihin eli toimenpiteisiin, jotka pyrkivät enemmänkin reagoimaan globaaleihin kehityskulkuihin.

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VTT PUBLICATIONS 653 Nordic ICT Foresight. Futures of the ICT environment and applications on the Nordic level

This publication deals with the futures of ICTs from the Nordic perspective. It maps the potential development trajectories of ICTs by using different foresight methods. The publication is based on the research conducted by four organizations: VTT Technical Research Centre of Finland, FOI (Sweden), SINTEF (Norway) and DTI (Denmark). The research was conducted in workshops that utilised structured foresight approaches. The workshops attracted ICT and policy experts from all the Nordic countries. The publication presents scenarios, roadmaps and action path analyses of the potential developments of ICTs on the Nordic level.

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